2005 Tri-Service Infrastructure Systems Conference & Exhibition

St. Louis, MO
"Re-Energizing Engineering Excellence"

2-4 August 2005

Agenda

Panel*:* The Future of Engineering and Construction

- LTG Carl A. Strock, Commander, USACE
- Dr. James Wright, Chief Engineer, NAVFAC

Panel*:* USACE Engineering and Construction

- Dr. Michael J. O'Connor, Director, R&D

Panel*:* Navy General Session

- Mr. Steve Geusic, Engineering Criteria & Programs NAVFAC Atlantic

Introduction to Multi-Disciplinary Tracks, by Mr. Gregory W. Hughes
Engineering Circular: Engineering Reliability Guidance for Existing USACE Civil Works Infrastructure, by Mr. David M. Schaaf, PE, LRD Regional Technical Specialist, Navigation Engineering Louisville District
MILCON S&A Account Study, by Mr. J. Joseph Tyler, PE, Chief, Programs Integration Division, Directorate of Military Programs HQUSACE
Financial Justification on Bentley Enterprise License Agreement (ELA)

Track 1

- The Chicago Shoreline Storm Damage Reduction Project, by Andrew Benziger
- Protecting the NJ Coast Using Large Stone Seawalls, by Cameron Chasten
- Cascade: An Integrated Coastal Regional Model for Decision Support and Engineering Design, by Nicholas C. Kraus and Kenneth J. Connell
- Modeling Sediment Transport Along the Upper Texas Coast, by David B. King Jr., Jeffery P. Waters and William R. Curtis
- Sediment Compatibility for Beach Nourishment in North Carolina, by Gregory L. Williams
- Evaluating Beachfill Project Performance in the USACE Philadelphia District, by Monica Chasten and Harry Friebel
- US Army Corps of Engineers' National Coastal Mapping Program, by Jennifer Wozencraft
- Flood Damage Reduction Project Using Structural and Non-Structural Measures, by Stacey Underwood
- Shore Protection Project Performance Improvement Initiative (S3P2I), by Susan Durden
- Hurricane Isabel Post-Storm Assessment, by Jane Jablonski
- US Army Corps of Engineers Response to the Hurricanes of 2004, by Rick McMillen and Daniel R. Haubner
- Increased Bed Erosion Due to Increased Bed Erosion Due to Ice, by Decker B. Hains, John I. Remus, and Leonard J. Zabilansky
- Mississippi Valley Division, by James D. Gutshall
- Impacts to Ice Regime Resulting from Removal of Milltown Dam, Clark Fork River, Montana, by Andrew M. Tuthill and Kathleen D. White, and Lynn A. Daniels
- Carroll Island Micromodel Study: River Miles 273.0-263.0, by Jasen Brown
- Monitoring the Effects of Sedimentation from Mount St. Helens, by Alan Donner, Patrick O'Brien and David Biedenharn
  Watershed Approach to Stream Stability and Benefits Related to the Reduction of Nutrients, by John B. Smith
- A Lake Tap for Water Temperature Control Tower Construction at Cougar Dam, Oregon, by Stephen Schlenker, Nathan Higa and Brad Bird
- San Francisco Bay Mercury TMDL – Implications for Constructed Wetlands, by Herbert Fredrickson, Elly Best and Dave Soballe
- Abandoned Mine Lands: Eastern and Western Perspectives, by Kate White and Kim Mulhern
  Translating the Hydrologic Tower of Babel, byDan Crawford
- Demonstrating Innovative River Restoration Technologies: Truckee River, Nevada, by Chris Dunn
- System-Wide Water Resource Management – Tools of the Trade

Track 2

- Ecological and Engineering Considerations for Dam Decommissioning, Retrofits, and Reoperations, by Jock Conyngham
- Hydraulic Design of tidegates and other Water Control structures for Ecosystem Restoration projects on the Columbia River estuary, by Patrick S. O'Brien
- Surface Bypass & Removable Spillway Weirs, by Lynn Reese
- Impacts of using a spillway for juvenile fish passage on typical design criteria, by Bob Buchholz
- Howard Hanson Dam: Hydraulic Design of Juvenile Fish Passage Facility in Reservoir with Wide Pool Fluctuation, by Dennis Mekkers and Daniel M. Katz
- Current Research in Fate Current Research in Fate & Transport of Chemical and Biological Contaminants in Water Distribution Systems, by Vincent F. Hock
- Regional Modeling Requirements, by Maged Hussein
- Tools for Wetlands Permit Evaluation: Modeling Groundwater and Surface Water Interaction, by Cary Talbot
- Ecosystem Restoration for Fish and Wildlife Habitat on the UMRS, by Jon Hendrickson
- Missouri River Shallow Water Habitat Creation, by Dan Pridal
- Aquatic Habitat Restoration in the Lower Missouri River, by Chance Bitner
- Transition to an Oracle Based Data System (Corps Water Management System, CWMS), by Joel Asunskis
- RiverGages.com: The Mississippi Valley Division Water Control Website, by Rich Engstrom
- HEC-ResSim 3.0: Enhancements and New Capabilities, by Fauwaz Hanbali
- Hurricane Season 2004 – Not to Be Forgotten, by Jacob Davis
- Re-Evaluation of a Flood Control Project, by Ferris W. Chamberlin
- Helmand Valley Water Management Plan, by Jason Needham
- A New Approach to Water Management Decision Making, by James D. Barton
- Developing Reservoir Operational Plans to Manage Erosion and Sedimentation during Construction – Willamette Temperature
- Control, Cougar Reservoir 2002-2005, by Patrick S. O'Brien
- Improved Water Supply Forecasts for the Kootenay Basin, by Randal T. Wortman
- ResSIM Model Development for Columbia River System, by Arun Mylvahanan
- Prescriptive Reservoir Modeling and the ROPE, by Jason Needham
- Missouri River Basin Water Management, by Larry Murphy

Track 3

- Corps Involvement in FEMA's Map Modernization Program, by Kate White, John Hunter and Mark Flick
- Innovative Approximate Study Method for FEMA Map Moderniation Program , by John Hunter
- Flood Fighting Structures Demonstration and Evaluation Program (FFSD), by Fred Pinkard
- Integrating Climate Dynamics Into Water Resources Planning and Management, by Kate White
- Hydrologic and Hydraulic Contributions to Risk and Uncertainty Propagation Studies, by Robert Moyer
- Uncertainty Analysis: Parameter Estimation, by Jackie P. Hallberg
- Geomorphology Study of the Middle Mississippi River, by Eddie Brauer
- Bank Erosion and Morphology of the Kaskaskia River, by Michael T. Rodgers
- Degradation of the Kansas City Reach of the Missouri River, by Alan Tool
- Sediment Impact Assessment Model (SIAM), by David S. Biedenharn and Meg Jonas
- Mississippi River Sedimentation Study, by Basil Arthur
- Sediment Model of Rivers, by Charlie Berger
- East Grand Forks, MN and Grand Forks, ND Local Flood Damage Reduction Project, by Michael Lesher
- Hydrologic and Hydraulic Analyses, by Thomas R. Brown
- Hydrologic and Hydraulic Modeling of the Mccook and Thornton Tunnel and Reservoir Plans, by David Kiel
- Ala Wai Canal Project, by Lynnette F. Schaper
- Missouri River Geospatial Decision Support Framework, by Bryan Baker and Martha Bullock
- Systemic Analysis of the Mississippi & Illinois Rivers Upper Mississippi River Comprehensive Plan, by Dennis L. Stephens

Section 227: National Shoreline Erosion Control Demonstration and Development Program Annual Workshop

- Workshop Objectives
- Section 227: Oil Piers, Ventura County, CA, by Heather Schlosser
- An Evaluation of Performance Measures for Prefabricated Submerged Concrete Breakwaters: Section 227 Cape May Point, New Jersey Demonstration Project, by Donald K Stauble, J.B. Smith and Randall A. Wise
- Bluff Stabilization along Lake Michigan, using Active and Passive Dewatering Techniques, by Rennie Kaunda, Eileen Glynn, Ron Chase, Alan Kehew, Amanda Brotz and Jim Selegean
- Storm Damage at Cape Lookout
- Branchbox Breakwater Design at Pickleweed Trail, Martinez, CA
- Section 227: Miami, FL
- Section 227: Sheldon Marsh Nature Preserve
- Section 227: Seabrook, New Hampshire
- Jefferson County, TX – Low Volume Beach Fill
- Sacred Falls, Oahsacred Falls, Oahu Section 227 Demonstration Project

Track 4

- Fern Ridge LakFern Ridge Lake Hydrologic Aspects of Operation during Failure, by Bruce J Duffe
- A Dam Safety Study Involving Cascading Dam Failures, by Gordon Lance
- Spillway Adequacy Analysis of Rough River Lake Louisville District, by Richard Pruitt
- Water Management in Iraq: Capability and Marsh Restoration, by Fauwaz Hanbali
- Iraq Ministry of Water Resources Capacity Building, by Michael J. Bishop, John W. Hunter, Jeffrey D. Jorgeson, Matthew M. McPherson, Edwin A. Theriot, Jerry W. Webb, Kathleen D. White, and Steven C. Wilhelms

- HEC Support of the CMEP Program, by Mark Jensen
- Geospatial Integration of Hydrology & Hydraulics Tools for Multi-Purpose, Multi-Agency Decision Support, by Timothy Pangburn, Joel Schlagel, Martha Bullock, Michael Smith, and Bryan Baker
- GIS & Surveying to Support FEMA Map Modernization and Example Bridge Report, by Mark Flick
- High Resolution Bathymetry and Fly-Through Visualization, by Paul Clouse
- Using GIS and HEC-RAS for Flood Emergency Plans, by Stephen Stello
- High Resolution Visualizations of Multibeam Data of the Lower Mississippi River, by Tom Tobin and Heath Jones
- System Wide Water Resources Program Unifying Technologies Geospatial Applications, by Andrew J. Bruzewicz
- Raystown Plate Locations
- Hydrologic Engineering Center: HEC–HMS Version 3.0 New Features, by Jeff Harris
- SEEP2D & GMS: Simple Tools for Solving a Variety of Seepage Problems, by Clarissa Hansen, Fred Tracy, Eileen Glynn, Cary Talbot and Earl Edris
- Sediment and Water Quality in HEC-RAS, by Mark Jensen
- Advances to the GSSHA Model, by Aaron Byrd and Cary Talbot
- Watershed Analysis Tool: HEC-WAT Program, by Chris Dunn
- Little Calumet River UnsteadLittle Calumet River Unsteady Flow Model Conversion UNET to HEC-RAS, by Rick D. Ackerson
  Kansas River Basin Model, by Edward Parker
- Design Guidance for Breakup Ice Control Structures, by Andrew M. Tuthill
- Computational Hydraulic Model of the Lower Monumental Dam Forebay, by Richard Stockstill, Charlie Berger, John Hite, Alex Carrillo, and Jane Vaughan
- Use of Regularization as a Method for Watershed Model Calibration, by Brian Skahill
- Demonstration Program Urban Flooding and Channel Restoration in Arid and Semi-Arid Regions (UFDP), by Joan Pope, Jack Davis, Ed Sing, John Warwick, Meg Jonas

Track 5

- Walla Walla District Northwestern Division, by Robert Berger
- Best Practices for Conduits through Embankment Dams, by Chuck R. Cooper
- Design, Construction Design, Construction and Seepage at Prado Dam, by Douglas E. Chitwood
- 2-D Liquefaction Evaluation with Q4Mesh, by David C. Serafini
- Unlined Spillway Erosion Risk Assessment, by Johannes Wibowo, Don Yule, Evelyn Villanueva and Darrel Temple
- Seismic Remediation of the Clemson Upper and Lower Diversion Dams; Evaluation, Conceptual Design and Design, by Lee Wooten and Ben Foreman
- Seismic Remediation of the Clemson Upper and Lower Diversion Dams; Deep Soil Mix Construction, by Lee Wooten and Ben Foreman
- Historical Changes in the State of the Art of Seismic Engineering and Effects of those changes on the Seismic Response Studies of Large Embankment Dams, by Sam Stacy
- Iwakuni Runway Relocation Project, by Vincent R. Donnally
- Internal Erosion & Piping at Fern Ridge Dam, by Jeremy Britton
- Rough River Dam Safety Assurance Project, by Timothy M. O’Leary
- Seepage Collection & Control Systems: The Devil is in the Details , by John W. France
- Dewey Dam Seismic Assessment, by Greg Yankey
- Seismic Stability Evaluation for Ute Dam, New Mexico, by John W. France
- An Overview of Criteria Used by Various Organizations for Assessment and Seismic Remediation of Earth Dams, by Jeffrey S. Dingrando
- A Review of Corps of Engineers Levee Seepage Practices and Proposed Future Changes, by George Sills
- Ground-Penetrating Radar Applications for the Assessment of Pavements, by Lulu Edwards and Don R. Alexander
- Peru Road Upgrade Project, by Michael P. Wielputz
- Slope Stability Evaluation of the Baldhill Dam Right Abutment, by Neil T. Schwanz
- Design and Construction of Anchored Bulkheads with Synthetic Sheet Piles Seabrook, New Hampshire, by Siamac Vaghar and Francis Fung
- Characterization of Soft Claya Case Study at Craney Island, by Aaron L. Zdinak
- Dispersive ClayDispersive Clays – Experience andHistory of the NRCS (Formerly SCS), by Danny McCook
- Post-Tensioning Institute, by Michael McCray
- Demonstration Program Urban Flooding and Channel Restoration in Arid and Semi-Arid Regions (UFDP), by Joan Pope, Jack Davis, Ed Sing, John Warwick, Meg Jonas

Track 6

- State of the Art in Grouting: Dams on Solution Susceptible or Fractured Rock Foundations, by Arthur H. Walz
- Specialty Drilling, Testing, and Grouting Techniques for Remediation of Embankment Dams, by Douglas M. Heenan
- Composite Cut-Offs for Dams, by Dr. Donald A. Bruce and Trent L. Dreese
- State of the Art in Grout Mixes, by James A. Davies
- State of the Art in Computer Monitoring and Analysis of Grouting, by Trent L. Dreese and David B. Wilson
- Quantitatively Engineered Grout Curtains, by David B. Wilson and Trent L. Dreese
- Grout Curtains at Arkabutla Dam: Outlet Monolith Joints and Cracks using Chemical Grout, Arkabutla Lake, MS, by Dale A. Goss
- Chicago Underflow Plan – CUP: McCook Reservoir Test Grout Program, by Joseph A. Kissane
- Clearwater Dam: Sinkhole Repair Foundation Investigation and Grouting Project, by Mark Harris
- Update on the Investigation of the Effects of Boring Sample Size (3” vs 5”) on Measured Cohesion in Soft Clays, by Richard Pinner and Chad M. Rachel
- Soil-Bentonite Cutoff Wall Through Free-Product at Indiana Harbor CDF, by Joe Schulenberg and John Breslin
- Soil-Bentonite Cutoff Wall Through Dense Alluvium with Boulders into Bedrock, McCook Reservoir, by William A. Rochford
- Small Project, Big Stability Problem the Block Church Road Experience, by Jonathan E. Kolber
- Determination of Foundation Rock Properties Beneath Folsom Dam, by Michael K. Sharp, José L. Llopis and Enrique E. Matheu
  Waterbury Dam Mitigation, by Bethany Bearmore
- Armor Stone Durability in the Great Lakes Environment, by Joseph A. Kissane
- Mill Creek - An Urban Flood Control Challenge, by Monica B. Greenwell
- Next Stop, The Twilight Zone, by Troy S. O’Neal
- Limitations in the Back Analysis of Shear Strength from Failures, by Rick Deschamps and Greg Yankey
- Reconstruction of Deteriorated Concrete Lock Walls After Blasting and Other Demolition Removal Techniques, by Stephen G. O'Connor

- Flood Fighting Structures Demonstration and Evaluation Program (FFSD), by George Sills
- Innovative Design Concepts Incorporated into a Landfill Closure and Reuse Design Portsmouth Naval Shipyard, Kittery, Maine, by Dave Ray and Kevin Pavlik
- Laboratory Testing of Flood Fighting Structures, by Johannes L. Wibowo, Donald L. Ward and Perry A. Taylor
- Bluff Stabilization Along Lake Michigan, Using Active and Passive Dewatering Techniques, Allegan Co. Michigan, by Rennie Kaunda, Eileen Glynn, Ron Chase, Alan Kehew and Jim Selegean

Track 7

- Case History: Multiple Axial Statnamic Tests on a Drilled Shaft Embedded in Shale, by Paul J. Axtell, J. Erik Loehr, Daniel L. Jones
- The Sliding Failure of Austin Dam Pennsylvania - Revisited, by Brian H. Greene
- M3 –Modeling, Monitoring and Managing: A Comprehensive Approach to Controlling Ground Movements for Protection of Existing Structures and Facilities, by Francis D. Leathers and Michael P. Walker
- Time-Dependent Reliability Modeling for Use in Major Rehabilitation of Embankment Dams and Foundation, by Robert C. Patev
- Lateral Pile Load Test Results Within a Soft Cohesive Foundation, by Richard J. Varuso
- Engineering Geology Challenge Engineering Geology Challenges During Design and Construction of the Marmet Lock Project, by Ron Adams and Mike Nield
- Mill Creek Deep Tunnel Geologic Conditions and Potential Impacts on Design/Construction, by Kenneth E. Henn III
- McAlpine Lock Replacement Instrumentation: Design, Construction, Monitoring, and Interpretation, by Troy S. O'Neal
- Geosynthetics and Construction of the Second Powerhouse Corner Collector Surface Flow Bypass Project, Bonneville Lock and Dam Project, Oregon and Washington, by Art Fong
- McAlpine Lock Replacement Project Foundation Characteristics and Excavation, by Kenneth E. Henn III
- Structural and Geotechnical Issues Impacting The Dalles Spillwall Construction and Bay 1 Erosion Repair, by Jeffrey M. Ament
  Rock Anchor Design and Construction: The Dalles Dam Spillwalls, by Kristie M. Hartfeil
- The Future of the Discrete Element Method in Infrastructure Analysis, by Raju Kala, Johannes L. Wibowo and John F. Peters
- Sensitive Infrastructure Sites - Sonic Drilling Offers Quality Control and Non-Destructive Advantages to Geotechnical Construction Drilling, by John P. Davis

Track 8

- Evaluation of The Use of LithiuEvaluation of The Use of Lithium Compounds in Controlling ASR in Concrete Pavement, by Mike Kelly
- Roller Compacted Concrete for McAlpine Lock Replacement, by David E. Kiefer
- Soil-Cement for Stream Bank Stabilization, by Wayne Adaska
- Using Cement to Reclaim Asphalt Pavements, by David R. Luhr
- Valley Park 100-Yr Flood Protection Project: Use of 'Engineered Fill' in the Item IV-B Levee Core, by Patrick J. Conroy
- Bluestone Dam: AAR –A Case Study, by Greg Yankey
- USDA Forest Service: Unpaved Road Stabilization with Chlorides, by Michael R. Mitchell
- Use of Ultra-Fine Amorphous Colloidal Silica to Produce a High-Density, High-Strength Grout, by Brian H. Green
- Modular Gabion Systems, by George Ragazzo
- Addressing Cold Regions Issues in Pavement Engineering, by Edel R. Cortez and Lynette Barna
- Geology of New York Harbor: Geological and Geophysical Methods of Characterizing the Stratigraphy for Dredging Contracts, by Ben Baker, Kristen Van Horn and Marty Goff
- Rubblization of Airfield Concrete Pavements, by Eileen M. Vélez-Vega
- US Army Airfield Pavement Assessment Program, by Haley Parsons, Lulu Edwards, Eileen Velez-Vega and Chad Gartrell
- Critical State for Probabilistic Analysis of Levee Underseepage, by Douglas Crum,
- Curing Practices for Modern Concrete Production, by Toy Poole
- AAR at Carters Dam: Different Approaches, by James Sanders
- Concrete Damage at Carters Dam, by Toy Poole
  Damaging Interactions Among Concrete Materials, by Toy Poole
- Economic Effects on Construction of Uncertainty in Test Methods, by Toy Poole
- Trends in Concrete Materials Specifications, by Toy Poole
- Spall and Intermediate-Sized Repairs for PCC Pavements, by Reed Freeman and Travis Mann
- Acceptance Criteria Acceptance Criteria for Unbonded Aggregate Road Surfacing Materials, by Reed Freeman, Toy Poole, Joe Tom and Dale Goss
- Effective Partnering to Overcome an Interruption In the Supply of Portland Cement During Construction at Marmet Lock and Dam, by Billy D. Neeley, Toy S. Poole and Anthony A. Bombich

Track 10

- Marmet Lock &Dam: Automated Instrumentation Assessment, Summer/Fall 2004, by Jeff Rakes and Ron Adams
  Success Dam Seismic Remediation

Track 9

- Fern Ridge Dam, Oregon: Seepage and Piping Concerns (Internal Erosion)

Track 11

- Canton Dam Spillway Stability: Is a Test Anchor Program Necessary?, by Randy Mead
- Dynamic Testing and Numerical Correlation Studies for Folsom Dam, by Ziyad Duron, Enrique E. Matheu, Vincent P. Chiarito, Michael K. Sharp and Rick L. Poeppelman

Status of Portfolio Risk Assessment, by Eric Halpin
- Mississinewa Dam Foundation Rehabilitation, by Jeff Schaefer
- Wolf Creek Dam Seepage Major Rehabilitation Evaluation, by Michael F. Zoccola
- Bluestone Dam DSA Anchor Challenges, by Michael McCray
- Clearwater Dam Major Rehab Project, by Bobby Van Cleave
- Design, Construction and Seepage at Prado Dam, by Douglas E. Chitwood
- Seven Oaks Dam: Outlet Tunnel Invert Damage, by Robert Kwan
- An Overview of An Overview of the Dam Safety ProgramManagement Tools (DSPMT), by Tommy Schmidt

Track 12

- Greenup L&D Miter Gate Repair and Instrumentation, by Joseph Padula, Bruce Barker and Doug Kish
- Marmet Locks and Dam Lock Replacement Project, by Jeffrey S. Maynard,
- Status of HSS Inspections in The Portland District, by Travis Adams
- Kansas City District: Perry Lake Project Gate Repair, by Marvin Parks
- Mel Price – Auxiliary Lock Downstream Miter Gate Repair, by Thomas J. Quigley, Brian K. Kleber and Thomas R. Ruf
- J.T. Myers Lock Improvements Project Infrastructure Conference, by David Schaaf and Greg Werncke
- J.T. Myers Dam Major Rehab, by David Schaaf, Greg Werncke and Randy James
- Greenup L&D, by Rodney Cremeans
- McAlpine Lock Replacement Project, by Kathy Feger
- Roller Compacted Concrete Placement at McAlpine Lock, by Larry Dalton
- Kentucky Lock Addition Downstream Middle Wall Monolith Design, by Scott A. Wheeler
- London Locks and Dam Major Rehabilitation Project, by David P. Sullivan
- Replacing Existing Lock 4: Innovative Designs for Charleroi Lock, by Lisa R. Pierce, Dave A. Stensby and Steve R. Stoltz
- Olmsted L&D, Dam In-the-wet Construction, by Byron McClellan, Dale Berner and Kenneth Burg
- Olmsted Floating Approach Walls, by Terry Sullivan
- John Day Navigation Lock Monolith Repair, by Matthew D. Hanson
- Inner Harbor Navigation Canal (IHNC) Lock Replacement, by Mark Gonski
- Comite River Diversion Project, by Christopher Dunn
- Waterline Support Failure: A Case Study, by Angela DeSoto Duncan
- Public Appeal of Major Civil Projects: The Good, the Bad and the Ugly, by Kevin Holden and Kirk Sunderman
- Chickamauga Lock and Dam Lock Addition Cofferdam Height Optimization Study, by Leon A. Schieber
- Des Moines Riverwalk, by Thomas D. Heinold

Track 13

- Folsom Dam Evaluation of Stilling Basin Performance for Uplift Loading for Historic Flows and Modification of Folsom Dam
- Stilling Basin for Hydrodynamic Loading, by Rick L. Poeppelman, Yunjing (Vicky) Zhang, and Peter J. Hradilek
- Seismic Stress Analysis of Folsom Dam, by Enrique E. Matheu
- Barge Impact Analysis for Rigid Lock Walls ETL 1110-2-563, by John D. Clarkson and Robert C. Patev
- Belleville Locks & Dam Barge Accident on 6 Jan 05, by John Clarkson
- Portugues Dam Project Update, by Alberto Gonzalez, Jim Mangold and Dave Dollar
- Portugues Dam: RCC Materials Investigation, by Jim Hinds
- Nonlinear Incremental Thermal Stress Strain Analysis Portugues Dam, by David Dollar, Ahmed Nisar, Paul Jacob and Charles Logie
- Seismic Isolation of Mission-Critical Infrastructure to Resist Earthquake Ground Shaking or Explosion Effects, by Harold O. Sprague, Andrew Whitaker and Michael Constantino
- Obermeyer Gated Spillway S381, by Michael Rannie
- Design of High Pressure Vertical Steel Gates Chicago Land Underflow Plan McCook Reservoir, by Henry W. Stewart, Hassan Tondravi, Lue Tekola,
- Development of Design Criteria for the Rio Puerto Nuevo Contract 2D/2E Channel Walls, by Janna Tanner, David Shiver, and Daniel Russell
- Indianapolis NortIndianapolis North Phase 3A Warfleigh Section
- Design of Concrete Lined Tunnels in Rock CUP McCook Reservoir Distribution Tunnels Contract, by David Force

Track 14

- GSA Progressive Collapse Design Guidelines Applied to Concrete Moment-Resisting Frame Buildings, by David N. Bilow and Mahmoud E. Kamara,
- UFC 4-023-02 Retrofit of Existing Buildings to Resist Explosive Effects, by Jim Caulder
- Summit Bridge Fatigue Study, by Jim Chu
- Quality Assurance for Seismic Resisting Systems, by John Connor
- Seismic Requirements for Arch, Mech, and Elec. Components, by John Connor
- SBEDS - (Single degree of freedom Blast Effects Design Spreadsheets), by Dale Nebuda,
- Design of Buildings to Resist Progressive Collapse UFC 4-023-03, by Bernie Deneke,
- Fatigue and Fracture Assessment, by Jesse Stuart
- Unified Facilities Criteria: Seismic Design for Buildings, by Jack Hayes
- Evaluation and Repair Of Blast Damaged Reinforced Concrete Beams, by MAJ John L. Hudson
- Building an In-house Bridge Inspection Program
- United Facilities CriteriUnited Facilities Criteria Masonry Design for Buildings, by Tom Wright
- USACE Homeland Security Portal, by Michael Pace
- Databse Tools for Civil Works Projects

- Standard Procedure for Fatigue Evaluation of Bridges, by Phil Sauser
- Consolidation of Structural Criteria for Military Construction, by Steven Sweeney
- Cathodic Protectionfor the South Power Plant Reinforcing Steel, Diego Garcia, BIOT, by Thomas Tehada and Miki Funahashi

Track 15

- Engineering Analysis of Airfield Lighting System Lightning Protection, by Dr. Vladimir A. Rakov and Dr. Martin A. Uman
- Dr. Martin A. Uman
- Charleston AFB Airfield Lighting Vault
- UNIFIED FACILITIES CRITERIA (UFC) UFC 3-530-01 Design: Interior, Exterior Lighting and Controls, by Nancy Clanton and Richard Cofer
- Electronic Keycard Access Locks, by Fred A Crum
- Unified Facilities Criteria (UFC) 3-560-02, Electrical Safety, by John Peltz and Eddie Davis
- Electronic Security SystemElectronic Security Systems Process Overview
- Lightning Protection Standards
- Electrical Military Workshop
- Information Technology Systems Criteria, by Fred Skroban and John Peltz
- Electrical Military Workshop
- Electrical Infrastructure in Iraq- Restore Iraqi Electricity, by Joseph Swiniarski

Track 16

- BACnet® Technology Update, by Dave Schwenk
- The Infrastructur Conference 2005, by Steven M. Carter Sr. and Mitch Duke
- Design Consideration for the Prvention of Mold, by K. Quinn Hart
- COMMISSIONING, by Jim Snyder
- New Building Commissioning , by Gary Bauer
- Ventilation and IAQ TheNew ASHRAE Std 62.1, by Davor Novosel
- Basic Design Considerations for Geothermal Heat Pump Systems, by Gary Phetteplace
- Packaged Central Plants
- Effective Use Of Evaporative Cooling For Industrial And Institutional/Office Facilities, by Leon E. Shapiro
- Seismic Protection For Mechanical Equipment
- Non Hazardous Chemical Treatments for Heating and Cooling Systems, by Vincent F. Hock and Susan A. Drozdz
- Trane Government Systems & Services
- LONWORKS Technology Update, by Dave Schwenk
- Implementation of Lon-Based Specifications by Will White and Chris Newman

Track 17

- Utility System Security and Fort Future, by Vicki Van Blaricum, Tom Bozada, Tim Perkins, and Vince Hock
- Festus/Crystal City Levee and Pump Station
- Chicago Underflow Plan McCook Reservoir (CUP) Construction of Distribution Tunnel and Pumps Installation
- Technological Advances in Lock Control Systems, by Andy Schimpf and Mike Maher
- Corps of Engineers in Iraq Rebuilding Electrical Infrastructure, by Hugh Lowe
- Red River of the North at East Grand Forks, MN & Grand Forks, ND: Flood Control Project – Armada of Pump Stations Protect Both Cities, by Timothy Paulus
- Lessons Learned for Axial/Mixed Flow Propeller Pumps, by Mark A. Robertson
- Creek Automated Gate Considerations, by Mark A. Robertson
- HydroAMP: Hydropower Asset Management, by Lori Rux
- Acoustic Leak Detection for Water Distribution Systems, by Sean Morefield, Vincent F. Hock and John Carlyle
- Remote Operation System, Kaskaskia Dam Design, Certification, & Accreditation, by Shane M. Nieukirk
- Lock Gate Replacement System, by Shaun A. Sipe and Will Smith

Track 20

- “Re-Energizing Medical Facility Excellence”, by COL Rick Bond
- Rebuilding and Renovating The Pentagon , by Brian T. Dziekonski,
- Resident Management System
- Design-Build and Army Military Construction, by Mark Grammer
- Defense Acquisition Workforce Improvements Act - Update, by Mark Grammer
- Construction Management @ Risk: Incentive Price Revision – Successive Targets, by Christine Hendzlik
- Construction Reserve Matrix, by Christine Hendzlik
- Award contingent on several factors..., by Christine Hendzlik
- 52.216-17 Incentive Price Revision--Successive Targets (Oct 1997) - Alt I (Apr 1984), by Christine Hendzlik
- Preconstruction Services, by Christine Hendzlik
- Proposal Evaluation Factors, by Christine Hendzlik
- MILCON Transformation in Support of Army Transformation, by Claude Matsui
- Construction Practices in Russia, by Lance T. Lawton

- Partnering as a Best Practice, by Ray Dupont
- USACE Tsunami Reconstruction for USAID, by Andy Constantaras

Track 21

- Dredging Worldwide, by Don Carmen
- SpecsIntact Editor, by Steven Freitas
- SpecsIntact Explorer, by Steven Freitas
- American River Watershed Project, by Steven Freitas
- Unified Facilities Guide Specifications (UFGS) Conversion To MasterFormat 2004, by Carl Kersten
- Unified Facilities Guide Specifications (UFGS) Status and Direction , by Jim Quinn

Workshops

- Design of Buildings to Resist Progressive Collapse UFC 4-023-03, by Bernie Deneke
- Security Engineering and at Unified Facility Criteria (UFC), by Bernie Deneke, Richard Cofer, John Lynch and Rudy Perkey
- Packaged Central Plants, by Trey Austin

NATIONAL DEFENSE INDUSTRIAL ASSOCIATION

STRENGTH THROUGH INDUSTRY & TECHNOLOGY

2005 Tri-Service Infrastructure Systems Conference & Exhibition

"Re-Energizing Engineering Excellence"

ON-SITE AGENDA

The America's Center
St. Louis Convention Center
St. Louis, MO
August 2-4, 2005
Event # 5150

Tri-Service Infrastructure Systems Conference & Exposition 2005

AGENDA

Monday, August 1, 2005

8:00 AM-9:00 PM	Exhibit Move-In
12 Noon-5:00 PM	Registration

Tuesday, August 2, 2005

7:00 AM-8:00 AM	Registration and Continental Breakfast
8:00 AM-8:15 AM Ferrara Theatre	Welcome and Introduction
8:15 AM-9:00 AM Ferrara Theatre	The Future of Engineering and Construction Panel Moderator: *Mr. Don Basham, Chief, Engineering & Construction, USACE* Panelists: *LTG Carl A. Strock, Commander, USACE* *Dr. James Wright, Chief Engineer NAVFAC*
9:00 AM-9:45 AM Ferrara Theater	Keynote Address The Lord of the Things: The Future of Infrastructure Technologies *Mr. Paul Doherty, AIA, Managing Director,* *General Land Corporation*
9:45 AM-10:15 AM	Break
10:15 AM-11:15 AM Ferrara Theatre	USACE Engineering and Construction Panel Moderator: *Mr. Don Basham, Chief, Engineering & Construction, USACE* Panelists: *MG Donald T. Riley, Director, Civil Works, USACE* *BG Bo M. Temple, Director, Military Programs, USACE* *Dr. Michael J. O'Connor, Director, R&D*
10:15 AM-11:15 AM Room 225	Navy General Session
11:00 AM - 7:00 PM	Exhibits Open
11:15 AM-1:00 PM	Lunch in Exhibit Hall (on your own)
11:15 AM-1:00 PM Washington G	Women's Career Lunch Session (Bring your lunch from Exhibit Hall) Moderator: *Ms. Demi Syriopoulou, HQ USACE* Opening Remarks: *LTG Carl A. Strock, Commander, USACE* Presentations & Discussion: *Dwight Beranek, Kristine Allaman, Donald Basham, HQ USACE*
1:00 PM-1:55 PM Ferrara Theatre	Introduction to Multi-Disciplinary Tracks

Tuesday, August 2, 2005

2:00 PM-2:50 PM — 1st Round of Multi-Disciplinary Concurrent Sessions (Continued)

Track 1: Acquisition Strategies for Civil Works
Room 230
Walt Norko

Track 2: Risk and Reliability Engineering
Room 231
Anjana Chudgar
David Schaaf

Track 3: Portfolio Risk Assessment
Room 232
Eric Halpin

Track 4: Hydrology, Hydraulics and Coastal Engineering Support for USACE
Room 240
Jerry Webb
Darryl Davis

Track 5: Civil Works R&D Forum
Room 241
Joan Pope

Track 6: Civil Works Security Engineering
Room 242
Joe Hartman
Bryan Cisar

Track 7: Building Information Model Applications
Room 226
Brian Huston
Daniel Hawk

Track 8: Design Build for Military Projects
Room 220
Mark Grammer

Track 9: Army Transformation/Global Posture Initiative/ Force Modernization
Room 221
Al Young
Claude Matsui

Track 10: Force Protection - Army Access Control Points
Room 222
John Trout

Track 11: Cost Engineering Forum on Government Estimates vs. Actual Costs
Room 227
Ray Lynn *Jack Shelton* *Kim Callan*
Miguel Jumilla *Ami Ghosh* *Joe Bonaparte*

Track 12: Engineering & Construction Information Technology
Room 228
MK Miles

Track 13: Sustainable Design
Room 223
Harry Goradia

Track 14: ACASS/CCASS/CPARS
Room 224
Ed Marceau
Marilyn Nedell

Track 15: Whole Building Design Guide
Room 229
Earle Kennett

Tuesday, August 2, 2005

2:50 PM-3:30 PM	Break in Exhibit Hall
3:30 PM-4:20 PM	2nd Round of Multi-Disciplinary Sessions
4:30 PM-5:20 PM	3rd Round of Multi-Disciplinary Sessions
5:30 PM-7:00 PM	Ice Breaker Reception in Exhibit Hall

Wednesday, August 3, 2005

7:00 AM-8:00 AM	Registration and Continental Breakfast
8:00 AM-9:30 AM	Concurrent Sessions (Please Refer to Concurrent Session Schedule on the Following Pages)
9:00 AM	Exhibit Hall Opens
9:30 AM-10:30 AM	Break in Exhibit Hall
10:30 AM-12:00 Noon	Concurrent Sessions (Please Refer to Concurrent Session Schedule on the Following Pages)
12:00 Noon-1:30 PM	Lunch in Exhibit Hall
1:30 PM-3:00 PM	Concurrent Sessions (Please Refer to Concurrent Session Schedule on the Following Pages)
3:00 PM-4:00 PM	Break in Exhibit Hall
4:00 PM-5:30 PM	Concurrent Sessions
5:00 PM	Exhibit Hall Closes

Thursday, August 4, 2005

7:00 AM-8:00 AM	Registration and Continental Breakfast
8:00 AM-9:30 AM	Concurrent Sessions (Please Refer to Concurrent Session Schedule on Following Pages)
9:30 AM-10:30 AM	Break in Exhibit Hall (Last Chance to view Exhibits)
10:30 AM-12:00 Noon	Concurrent Sessions (Please Refer to Concurrent Session Schedule on Following Pages)
12:00 Noon-1:30 PM	Lunch (On your own)
12:00 Noon-6:00 PM	Exhibits Move-Out
1:30 PM-3:00 PM	Concurrent Sessions (Please Refer to Concurrent Session Schedule on Following Pages)
3:00 PM-3:30 PM	Break
3:30 PM-5:00 PM	Concurrent Sessions (Please Refer to Concurrent Session Schedule on following pages)

Wednesday, August 3, 2005 Concurrent Sessions

HH&C Track

Room	Track / Session	8:00 AM	8:30 AM	9:00 AM	9:30 AM	Track / Session	10:30 AM	11:00 AM	11:30 AM
Room 220	**TRACK 1** Coastal Structures Session 1A	Protecting the NJ Coast using large stone seawalls *Cameron Chasten*	Chicago shoreline storm damage reduction project *Andrew Bezinger*	Risk and reliability in coastal structure design *Jeffrey Melby*	Break in Exhibit Hall	**TRACK 1** Coastal Regional Manangement Session 1B	Cascade: An integrated regional model for decision support *Nicholas Kraus*	Upper Texas coast sediment transport modeling & sediment budgets *David King*	Sediment compatibility for beach nourishment in North Carolina *Gregory Williams*
Room 221	**TRACK 2** Ecological Engineering & Design Session 2A	Ecological and engineering considerations for dam decommissioning, retrofits and operations *Jock Conyngham*	Hydraulic design of tidegates and other water control structures for ecosystem restoration on the Columbia Estuary *Patrick O'Brien*	Innovative Integration of engineering and biological tools aids hydraulic structure design for restoring T&E fish *Andrew Goodwin*	Break in Exhibit Hall	**TRACK 2** Ecological Engineering & Design Session 2B	Innovative hydraulic structure design at Lower Granite Dam: design that saves water and salmon *Lynn Reese*	Impacts of using a spillway for juvenile fish passage on typical design criteria *Robert Buchholz*	Hydraulic design of juvenile fish passage facility for reservoir with wide range of pool elevation - Hanson Dam *Dennis Mekkers*
Room 222	**TRACK 3** Modeling Session 3A	Corps involvement in the FEMA map modernization program *Kete White*	Innovative approximate study method for FEMA map modernization program *John Hunter*	Flood fight structures demonstration evaluation program *Fred Pinkard*	Break in Exhibit Hall	**TRACK 3** Modeling Session 3B	Integrating climate dynamics into water resources planning and management *Kate White*	Risk and uncertainty in flood damage reduction studies *Rob Moyer*	Uncertainty analysis and stochastic simulation *Jacke Hallberg*
Room 223	**TRACK 4** H&H Aspects of Dam Safety Session4A	Hydrologic aspects of operating in failure mode: Fern Lake *Bruce Duffe*	Dam safety study with cascading failures *Gordon Lance*	Rough river spillway capacity *Richard Pruitt*	Break in Exhibit Hall	**TRACK 4** International / Military H&H Session 4B	Capability restoration and historic marsh restoration *Fauwaz Hanbali*	USACE capacity building effort for Iraq MoWR *Steven Wilhelms*	USACE support of CMEP in 2004 *Mark Jensen*

12 Noon — Lunch in Exhibit Hall

Room	Track / Session	1:30 PM	2:00 PM	2:30 PM	3:00 PM	Track / Session	4:00 PM	4:30 PM	5:00 PM
Room 220	**TRACK 1** Coastal Sediments Session 1C	Evaluating beachfill project performance in the NAP *Monica Chasten*	USACE's regional coastal mapping program *Jennifer Wozencraft*	US Naval Academy flood damage reduction project using structural and non-structural measures *Stacey Underwood*	Break in Exhibit Hall	**TRACK 1** Shore Protection Projects Session 1D	Hurricane Isabel effects on communities *Jane Jablonski*	Repair of the shore protection projects adversly affected by the hurricanes of 2004 *Rick McMillen*	Shore protection project performance assessmet *Sharon Haggett*
Room 221	**TRACK 2** Modeling Ecological Restoration / Systems Assessment Session 2C	Regional modeling requirements for ecosystem restoration *Maged Hussein*	Tools for wetlands permit evaluation: Modeling groundwater and surface water distribution systems *Cary Talbot*	Current research in fate and transport of chemical and biological contaminants in water distribution systems *Mark Ginsberg*	Break in Exhibit Hall	**TRACK 2** Ecosystem Habitat Restoration Session 2D	Aquatic habitat restoration in the lower Missouri River *Chance Bittner*	Missouri River restoration: shallow water habitat creation *Daniel Pridal*	Ecosystem restoration for fish and wildlife habitat on the upper Mississippi River *Jon Hendrickson*
Room 222	**TRACK 3** River Morphology Session 3C	Geomorphology study of the Mississippi river *Edward Braurer*	Bank erosion and morphology of the Kaskaskia river *Michael Rodgers*	Sediment movement at Kansas City from water years 1920 to 2004 *Alan Tool*	Break in Exhibit Hall	**TRACK 3** Modeling River Sedimentation Session 3D	Sediment impact assessment model (SIAM) *David Biedenharn*	Sediment modeling of MS River, Cairo to Gulf *Basil Arthur*	Sediment modeling of rivers *Charlie Berger*
Room 223	**TRACK 4** GIS and Surveying Session 4C	GIS tools available now to support HHC *Timothy Pangburn*	High resolution bathymetry and fly-through visualization *Paul Clouse*	GIS & surveying to support national FEMA *Mark Flick*	Break in Exhibit Hall	**TRACK 4** GIS and Surveying Session 4D	Update flood emergency plans with GIS and HEC-RAS *Stephen Stello*	High resolution visualizations of multibeam data: lower Mississippi River *Thomas Tobin*	GIS in SWWRP *Andrew Bruzewicz*

Wednesday, August 3, 2005 Concurrent Sessions

Geotechnical Track

Room	Track / Session	8:00 AM	8:30 AM	9:00 AM	9:30 AM	10:30 AM	11:00 AM	11:30 AM
Room 226	TRACK 5 / Session 5A	Levee lowering for the Lewis & Clark bi-centennial celebration *Robert Berger*	Conduits through embankment dams - best practices for design, construction, problem id and evaluation, inspection, maintenance, renovation & repair *Dave Pezza*	Design, construction and seepage at Prado Dam, CA *Douglas Chitwood*	Break in Exhibit Hall	TRACK 5 / Session 5B: 2-D liquefaction evaluation with q4MESH *David Serafini*	Unlined spillway erosion risk assessment *Johannes Wibowo*	Seismic remediation of the Clemson upper and lower diversion dams: evaluation, conceptal design and design (P1) *Ben Foreman*
Room 227	TRACK 6 / Session 6A	USACE dams on solution susceptible or highly fractured rock foundations *Art Walz*	Special drilling and grouting techniques for remedial work in embankment dams *Doug Heenan*	Composite grouting & cutoff wall solutions *Donald Bruce*	Break in Exhibit Hall	TRACK 6 / Session 6B: State of the art in grout mixes *James Davies*	State of the art in computer monitoring, control, and analysis of grouting *Trent Dreese*	Quantitatively engineered grout courtains *David Wilson*
Room 228	TRACK 7 / Session 7A	Case history: multiple axial statnamic test on a drilled shaft embedded in shale *Paul Axtell*	Austin Dam, Pennsylvania: the sliding failure of a concrete gravity dam revisited *Brian Greene*	M[3] (Modeling, Monitoring and Manufacturing) - a comprehensive approach to controlling ground movements for protecting existing structures and facilities *Michael Walker*	Break in Exhibit Hall	TRACK 7 / Session 7B: Controlled modulus columns: A ground improvement technique *Martin Taube*	Time-dependent reliability models for use in major rehabilitation of embankment dams and foundations *Robert Patev*	Engineering geology design challenges at the Soo Lock replacement project *Mike Nield*
Room 229	TRACK 8 / Session 8A	Evaluation of the use of lithium nitrate in controlling alkali-silica reactivity in an existing concrete pavement *Mike Kelly*	Use of self-consolidating concrete in the installation of bulhead slots - Lessons learned in the use of this innovative concrete material *Darrell Morey*	Roller compacted concrete for McAlpine lock walls *David Kiefer*	Break in Exhibit Hall	TRACK 8 / Session 8B: Soil-cement for stream bank stabilization *Wayne Adaska*	Using cement to reclaim asphalt pavements *David Luhr*	Valley park 100-year flood protection project: use of "engineered fill" in item 4b levee core *Patrick Conroy*

12 Noon — **Lunch in Exhibit Hall**

Room	Track / Session	1:30 PM	2:00 PM	2:30 PM	3:00 PM	4:00 PM	4:30 PM	5:00 PM
Room 226	TRACK 5 / Session 5C	Seismic remediation of the Clemson upper and lower diversion dams: deep soil mix construction *Ben Foreman*	Historical changes in the state-of-the-art of seismic engineering & effects of those changes on the seismic response studies of large embankement dams *Samuel Stacy*	New Iwakuni runway *Vincent Donnally*	Break in Exhibit Hall	TRACK 5 / Session 5D: Internal erosion and piping at Fern Ridge dam: Problems and solutions *Jeremy Britton, Ph.D.*	Rough river dam safety assurance project *Timothy O'Leary*	Seepage collection and control systems: The devil is in the details *John France*
Room 227	TRACK 6 / Session 6C	Grout courtains at Arkabutla Dam outlet monolith joints using chemical grout to seal joints, Arkabutla, MS *Dale Goss*	Results from a large-scale grout test program, Chicago underflow plan (CUP) McCook Reservoir *Joseph Kissane*	Clearwater Dam - foundation drilling and grouting for repair of sinkholes *Mark Harris*	Break in Exhibit Hall	TRACK 6 / Session 6D: Update on the investigation of the effects of boring sample size (3' vs 5") on measured cohesion in soft clays *Richard Pinner*	Soil-bentonite cutoff wall through free-product at Indiana Harbor CDF *Joseph Schulenberg*	Soil-bentonite cutoff wall through dense alluvium with boulders into bedrock, McCook Reservoir *William Rochford*
Room 228	TRACK 7 / Session 7C	Engineering geology during design and construction of the Marmet lock project *Michael Nield*	Mill Creek deep tunnel - Geological affects on proposed structures and construction techniques *Tres Henn*	Earth pressure loads behind the new McAlpine Lock replacement project *Troy O'Neal*	Break in Exhibit Hall	TRACK 7 / Session 7D: Geosynthetics and construction of the Bonneville lock and dam second powerhouse corner collector surface flow bypass project *Art Fong*	McAlpine lock replacement - foundation characteristics and excavation *Kenneth Henn*	
Room 229	TRACK 8 / Session 8C	What to do if your dam is expanding: a case study *Greg Yankey*	Unpaved road stabilization with chlorides *Michael Mitchell*	Use of ultra-fine amorphous colloidal silica to produce a high-density, high-strength rock-matching grout for instrumentation grouting *Brian Green*	Break in Exhibit Hall	TRACK 8 / Session 8D: Innovative techniques in the Gabion system *George Ragazzo*	Addressing cold regions issues in pavement engineering *Lynette Barna*	Geology of New York Harbor - geological and geophysical methods of characterizing the stratigraphy for dredging contracts *Ben Baker*

Wednesday, August 3, 2005 Concurrent Sessions

Structural Engineering Track

Room	Track	8:00 AM	8:30 AM	9:00 AM	9:30 AM	Track	10:30 AM	11:00 AM	11:30 AM
Room 240	**TRACK 12** Civil Works Structural **Session 12A**	Recent changes to Corps guidance on steel hydraulic structures *Joe Padula*	Crack repairs and instrumentation of Greenup L&D miter gate *Doug Kish*	Recent hydraulic steel structures findings in the Portland district *Travis Adams*	Break in Exhibit Hall	**TRACK 12** Civil Works Structural **Session 12B**	Perry Lake gate repair *Marvin Parks*	Mel Price auxiliary lock gate repair *Andrew Schimpf*	Mel Price auxiliary lock gate repair (Continued) *Andrew Schimpf*
Room 241	**TRACK 13** Civil Works Structural **Session 13A**	Folsom Dam evaluation of stilling basin performance for uplift loading for historic flows *Rick Poeppelman*	Rehabilitation of Folsom Dam stilling basin *Rick Poeppelman*	Seismic stability evaluation of Folson Dam *Enrique Matheu*	Break in Exhibit Hall	**TRACK 13** Civil Works Structural **Session 13B**	Seismic stress analysis of Folsom Dam *Enrique Matheu*	Barge impact guidance for rigid lock walls, ETL 110-2-563 and probalistic barge impact analysis *John Clarkson*	Belleville barge accident *John Clarkson*
Room 242	**TRACK 14** Bridges/ Buildings **Session 14A**	The USACE bridge management system *Phil Sauser*	Standard procedures for fatigue evaluation of bridges *Phil Sauser*	Fatigue and fracture assessment of Jesse Stuart Highway Bridge *John Jaeger*	Break in Exhibit Hall	**TRACK 14** Bridges/ Buildings **Session 14B**	Building an in-house bridge inspection program *Jennifer Laning*	Fatigue analysis of Summit bridge *Jim Chu*	Consolidation of Structural criteria for military construction *Steve Sweeney*

12 Noon **Lunch in Exhibit Hall**

Room	Track	1:30 PM	2:00 PM	2:30 PM	3:00 PM	Track	4:00 PM	4:30 PM	5:00 PM
Room 240	**TRACK 12** Civil Works Structural **Session 12C**	Overview of John T. Myers locks improvements project *Greg Werncke*	John T. Myers rehabilitation study *Greg Werncke*	Ohio River Greenup Lock extension *Rodney Cremeans*	Break in Exhibit Hall	**TRACK 12** Civil Works Structural **Session 12D**	McAlpine lock replacement project, project summary and status of construction *Kathleen Feger*	Results of Roller Compacted concrete placement at the McAlpine lock replacement project *Larry Dalton*	Tennessee Valley authority Kentucky lock addition downstream middle wall monoliths *Scott Wheeler*
Room 241	**TRACK 13** Civil Works Structural **Session 13C**	Portugues Dam, Ponce, Puerto Rico project update *Jim Mangold*	Portugues Dam, Ponce, Puerto Rico, RCC design and testing program *Jim Hinds*	Portugues Dam, Ponce, Puerto Rico, Thermal analysis of hydration and subsequent cooling of RCC *Ahmed Nisar*	Break in Exhibit Hall	**TRACK 13** Civil Works Structural **Session 13D**	Miter gate anchorage design *Andy Harkness*	Obermeyer gated spillway project - S381 *Michael Rannie*	McCook Reservoir design of high pressure steel gates *Luelseged Tekola*
Room 242	**TRACK 14** Brigdes/ Buildings **Session 14C**	Unified facilities criteria seismic design for buildings *Jack Hayes*	Seismic requirements for architectural, mechanical and electrical components *John Connor*	Quality assurance for seismic resisting systems *John Connor*	Break in Exhibit Hall	**TRACK 14** Bridges/ Buildings **Session 14D**	Unified facilities criteria masonry structural design for buildings *Tom Wright*	Cathodic protection of building reinforcing steel (in Diego Garcia) *Thomas Tehada*	USACE Homeland security web portal *Mike Pace*

Wednesday, August 3, 2005 Concurrent Sessions

Dam Safety Track & Construction Track

Room	Track / Session	8:00 AM	8:30 AM	9:00 AM	9:30 AM	Track / Session	10:30 AM	11:00 AM	11:30 AM
Room 224	**TRACK 10 Dam Safety** Session 10A	Tuttle Creek warning and alert systems *Bill Empson*	Lessons from the dam failure warning system exercise - Tuttle Creek *Bill Empson*	Tuttle Creek ground modification treatability program *Bill Empson*	Break in Exhibit Hall	**TRACK 10 Dam Safety** Session 10B	Dam safety analysis of Cannelton Dam *Terry Sullivan*	John Martin Dam, CO - Dam safety structural upgrades *George Diewald*	Vesuvius Lake Dam rehabilitation *Susan Peterson*
Room 225	**TRACK 11 Dam Safety** Session 11A	Canton lake spillway stabilization project: IS a test anchor program NECESSARY? *Randy Mead*	Dynamic testing and numerical correlation studies for Folsom dam *Ziyad Duron*	Status of portfolio risk assessment *Eric Halpin*	Break in Exhibit Hall	**TRACK 11 Dam Safety** Session 11B	Mississinewa Dam remediation *Jeff Schaefer*	Wolf creek seepage history *Michael Zoccola*	Blue dam major rehabilitation *Michael McCray*
Room 230	**TRACK 19 Construction** Session 19A	RMS Update *Haskell Barker*	RMS Update (Continued) *Haskell Barker*	Updated CQM for Contractors Course *Walt Norko*	Break in Exhibit Hall	**TRACK 19 Construction** Session 19B	Lessons learned on major construction projects *Jim Cox*	Update on safety issues - Safety manual 385-1-1 *Charles Ray Waits*	Update on safety issues - safety manual 385-1-1 (continued) *Charles Ray Waits*
Room 231	**TRACK 20 Construction** Session 20A	Construction methods in Russia *Lance Lawton*	Construction methods in Russia (Continued) *Lance Lawton*	Renovating the Pentagon using Design/Build delivery *Brian Dziekonski*	Break in Exhibit Hall	**TRACK 20 Construction** Session 20B	Completion of the Olmsted approach walls *Dale Miller*	Completion of the Olmsted approach walls (Continued) *Dale Miller*	Construction management at risk *Christopher Prinslow*

12 Noon **Lunch in Exhibit Hall**

Room	Track / Session	1:30 PM	2:00 PM	2:30 PM	3:00 PM	Track / Session	4:00 PM	4:30 PM	5:00 PM
Room 224	**TRACK 10 Dam Safety** Session 10C	Project specific risk analysis - Success Dam *Ronn Ross*	Dam safety lessons learned, Winter storm 2005, Muskingum & Scioto Basins *Charles Barry*	Dam security and Dams Government Coordinating Council *Roy Braden*	Break in Exhibit Hall	**TRACK 10 Dam Safety** Session 10D	Prompton Dam hydrologic deficiency and spillway modification *Troy Cosgrove*	"Well, that's water over the dam" - Rough River spillway adequacy design *Richard Pruitt*	Roller-compacted concrete for dam spillways and overtopping protection *Fares Abdo*
Room 225	**TRACK 11 Dam Safety** Session 11C	Clearwater Dam major rehabilitation *Bobby Van Cleave*	Success dam seismic dam safety modification *Norbert Suter*	Problems on the Santa Ana River - Prado Dam *Douglas Chitwood*	Break in Exhibit Hall	**TRACK 11 Dam Safety** Session 11D	Problems on the Santa Ana River - Seven Oaks Dam *Robert Kwan*	Dam safety program management tools *Tommy Schmidt*	
Room 230	**TRACK 19 Construction** Session 19C	3D Modeling and impact on constructability *Gary Cough*	3D Modeling and impact on constructability (Continued) *Gary Cough*	Construction in Iraq & Afganistan *Walt Norko*	Break in Exhibit Hall	**TRACK 19 Construction** Session 19D	Air Force streamlining Design/Build *Joel Hoffman*	Air Force streamlining Design/Build (Continued) *Joel Hoffman*	Sustainable design requirements & construction implementation *Harry Goradia*
Room 231	**TRACK 20 Construction** Session 20C	Tsunami reconstruction *Andy Constantaras*	Tsunami reconstruction (Continued) *Andy Constantaras*	Military construction transformation in support of Army transformation *Sally Parsons*	Break in Exhibit Hall	**TRACK 20 Construction** Session 20D	MEDCOM Construction Issues *Rick Bond*	MEDCOM Construction Issues (Continued) *Rick Bond*	*TBA*

Wednesday, August 3, 2005 Concurrent Sessions

Electrical & Mechanical Engineering Track

Room	Track / Session	8:00 AM	8:30 AM	9:00 AM	9:30 AM	Track / Session	10:30 AM	11:00 AM	11:30 AM
Room A	**TRACK 15** Military Electrical — **Session 15A**	Tri-Service Electrical Criteria Overview - *Tri-Service Panel*	Tri-Service Electrical Criteria Overview - (Continued) *Tri-Service Panel*	Tri-Service Electrical Criteria Overview -(Continued) *Tri-Service Panel*	Break in Exhibit Hall	**TRACK 15** Military Electrical — **Session 15B**	Interior/Exterior and security lighting criteria *Tri-Service Panel*	Information technology systems criteria *Tri-Service Panel*	Information technology systems criteria (Continued) *Tri-Service Panel*
Room B	**TRACK 16** Military Mechanical — **Session 16A**	Building Commissioning *Dale Herron*	HVAC Commissioning *Dale Herron*	Ventilation and indoor air quality *Davor Novosel*	Break in Exhibit Hall	**TRACK 16** Military Mechanical — **Session 16B**	Ventilation and indoor air quality (Continued) *Davor Novosel*	Refrigerant implications for HVAC specifications, selection, and o&m - now and future *Mike Thompson*	Refrigerant implications for HVAC specifications, selection, and o&m - now and future (Continued) *Mike Thompson*
Room D	**TRACK 17** Military Mechanical / Electrical — **Session 17A**	Sustainable design update *Harry Goradia*			Break in Exhibit Hall	**TRACK 17** Military Mechanical / Electrical — **Session 17B**	Utility systems security and fort future *Vicki L. Van Blaricum*	Acoustic leak detection for utilities distribution systems *Sean Morefield*	Acoustic leak detection for utilities distribution systems (Continued) *Sean Morefield*
Room E	**TRACK 18** Civil Mechanical — **Session 18A**	Emsworth Dam vertical lift gate hoist replacement *John Nites*	Hydraulic drive for Braddock Dam *Janine Krempa*	John Day navigation lock upstream lift gate wire rope failure *Ronald Wridge*	Break in Exhibit Hall	**TRACK 18** Civil Mechanical — **Session 18B**	Overhead bulkhead at Olmstead Lock *Rick Schultz*	Replacement of gate # 5 intermediate gear and pinion at RC Byrd Lock and Dam *Brenden McKinley*	Mechanical design issues during construction of McAlpine Lock *Richard Nichols*

12 Noon **Lunch in Exhibit Hall**

Room	Track / Session	2:00 PM	2:30 PM	3:00 PM	3:30 PM	Track / Session	4:00 PM	4:30 PM	5:00 PM
Room A	**TRACK 15** Military Electrical — **Session 15C**	Mass notification system *Tri-Service Panel*	Mass notification system (Continued) *Tri-Service Panel*	Electronic card access locks *Fred Crum*	Break in Exhibit Hall	**TRACK 15** Military Electrical — **Session 15D**	Lightning protection standards *Richard Bouchard*	Lightning and surge protection *Tri-Service Panel*	Lightning and surge protection (Continued) *Tri-Service Panel*
Room B	**TRACK 16** Military Mechanical — **Session 16C**	Basic design considerations for geothermal heat pump systems *Gary Phetteplace*	Basic design considerations for geothermal heat pump systems (Continued) *Gary Phetteplace*	Pentagon renovation *Mitch Duke*	Break in Exhibit Hall	**TRACK 16** Military Electrical — **Session 16D**	Effective use of evaporative cooling for industrial and institutional/office facilities *Leon Shapiro*	Efective use of evaporative cooling for industrial and institutional/office facilities (Continued) *Leon Shapiro*	Non-hazardous chemical treatments for heating and cooling systems *Vincent Hock*
Room D	**TRACK 17** Civil Mechanical / Electrical — **Session 17C**	Hydropower asset management partnership (hydroAMP) *Lori Rux*	New gas fueled/diesel fueled turbine powered electrical generating station in Iraq *Lester Lowe*	The construction of distribution tunnels and pump installation for the metropolitan Chicago sewer systems *Ernesto Go*	Break in Exhibit Hall	**TRACK 17** Civil Mechanical / Electrical — **Session 17D**	The Festus/Crystal City levee and pump station project *Stephen Farkas*	Remote operations for Kaskaskia Dam *Shane Nieukirk*	Technological advances in lock control systems *Andy Schimpf*
Room E	**TRACK 18** Civil Mechanical — **Session 18C**	New coating products for civil works structures *Al Beitelman*	New guide specification for procurement of turbine oils *John Micetic*	Synchronous condensing with large Kaplan turbine - A case study *Brian Moentenich*	Break in Exhibit Hall	**TRACK 18** Civil Mechanical — **Session 18D**	Acquifer storage and recovery (ASR) system *Gerald Deloach*	Wastewater infrastructure improvements in Appalachia *James Sadler*	Storm water pumps *Thomas Jamieson*

Thursday, August 4, 2005 Concurrent Sessions

HH&C Track

Room	Track / Session	8:00 AM	8:30 AM	9:00 AM	9:30 AM	Track / Session	10:30 AM	11:00 AM	11:30 AM
Room 220	**TRACK 1 Sedimentation & New Concepts** Session 1E	Ice jams, contaminated sediment and structures Clark Fork River, MT *Andrew Tuthill*	Increased bed erosion due to ice *John Hains*	Monitoring the Mississippi River using GPS coordinated video *James Gutshall*	Break in Exhibit Hall	**TRACK 1 Sedimentation, Case Examples** Session 1F	Watershed approach to stream stability the reduction of nutrients *John B. Smith*	Monitoring the effects of sedimentation from Mount St. Helen *Alan Donner*	Navigation and environmental interests in alleviating repetitive dredging *Jason Brown*
Room 221	**TRACK 2 Water Management** Session 2E	Enhancements and new capabilities of HEC-ResSim 3.0 *Fauwaz Hanbali*	Transition to Oracle based data system *Joel Asunskis*	Accessing real time Mississippi Valley water level data *Rich Engstrom*	Break in Exhibit Hall	**TRACK 2 Water Management** Session 2F	Hurricane Season 2004 *Susan Sylvester*	Reevaluation of a project's flood control benefits *Ferris Chamberlin*	Helmand Valley water management plan *Jason Needham*
Room 222	**TRACK 3 Case Studies** Session 2E	Red River of the north flood protection project *Michael Lesher*	Southeast Arkansas flood control & water supply feasibility study *Thomas Brown*	McCook and Thorton tunnel and reservoir modeling *David Kiel*	Break in Exhibit Hall	**TRACK 3 Case Studies** Session 3F	Ala Wai Canal Project, Honolulu, Oahu, Hawaii *Lynnette Schapers*	Missouri River geospatial decision support framework *Brian Baker*	Systemic analysis of the Mississippi & Illinois Rivers *Dennis Stephens*
Room 223	**TRACK 4 Modeling** Session 4E	Hydrologic models supported by ERDC *Robert Wallace*	HEC-HMS Version 3.0 new features *Jeff Harris*	SEEP2D & GMS: Simple tools for solving a variety of seepage problems *Clarissa Hansen*	Break in Exhibit Hall	**TRACK 4 Modeling** Session 4F	Water quality and sediment transport in HEC-RAS *Mark Jensen*	Advances to the GSSHA program *Aaron Byrd*	Software integration for watershed studies HEC-WAT *Chris Dunn*

12 Noon — **Lunch**

Room	Track / Session	1:30 PM	2:00 PM	2:30 PM	3:00 PM	Track / Session	3:30 PM	4:00 PM	4:30 PM
Room 220	**TRACK 1 Water Quality Management** Session 1G	San Francisco Bay Mercury TMDL-Implications for constructed wetlands *Herb Fredrickson*	Abandoned mine land: Eastern and Western perspectives *Kate White*	A lake tap for temperature control tower construction at Cougar Dam *Steve Schlenker*	Break	**TRACK 1 Watershed Management** Session 1H	Demonstrating innovative river restoration technologies: Truckee River, NV *Chris Dunn*	Comprehensive watershed restoration in the Buffalo district *Anthony Friona*	Translating the hydrologic tower of Babel *Dan Crawford*
Room 221	**TRACK 2 Water Management** Session 2G	Developing reservoir operation plans to manage erosion *Patrick O'Brien*	New approaches to water management decision making *James Barton*	Improved water supply forecasts for Kooteny basin using principal components regression *Randal Wortman*	Break	**TRACK 2 Water Management** Session 2H	Prescriptive reservoir modeling and ROPE study *Jason Needham*	Missouri River mainstem operations *Larry Murphy*	Res-Sim model for the Columbia River *Arun Mylvahanan*
Room 222	**TRACK 3 Section 227** Session 3G	Section 227 Workshop/ Program Review *William Curtis*	Section 227 Workshop/ Program Review (Continued) *William Curtis*	Section 227 Workshop/ Program Review (Continued) *William Curtis*	Break	**TRACK 3 Section 227** Session 3H	Section 227 Workshop/ Program Review *William Curtis*	Section 227 Workshop/ Program Review (Continued) *William Curtis*	Section 227 Workshop/ Program Review (Continued) *William Curtis*
Room 223	**TRACK 4 Modeling** Session 4G	Little Calumet River unsteady flow model conversion *Rick Ackerson*	Kansas City River basin model *Edward Parker*	Design guidance for breakup ice control *Andrew Tuthill*	Break	**TRACK 4 Modeling** Session 4H	Forebay flow simulations using Navier-Stokes code *Charlie Berger*	Use of regularizatino as a method for watershed model calibration *Brian Skahill*	Demonstration program in the arid southwest *Margaret Jonas*

Thursday, August 4, 2005 Concurrent Sessions

Geotechnical Track

Room	Track / Session	8:00 AM	8:30 AM	9:00 AM	9:30 AM	Track / Session	10:30 AM	11:00 AM	11:30 AM
Room 226	TRACK 5 Session 5E	Dynamic deformation analyses Dewey Dam Huntintong District Corps of Engineers *Greg Yankey*	Seismic stability evaluation for Ute Dam, NM *John France*	An overview of criteria used by various organizations for assessments and seismic remediation of earth dams *Sean Carter*	Break in Exhibit Hall	TRACK 5 Session 5F	USACE seepage berm design criteria and district practices *George Sills*	Ground penetrating radar applications for the assessment of airfield pavements *Lulu Edwards*	Challenges of the Fernando Belaunde Terry road upgrade Campanillia to Pizana - Peru road project *Michael Wielputz*
Room 227	TRACK 6 Session 6E	Small geotechnical project, big stability problem - The Block Church Road experience *Jonathan Kolber*	Geophysical investigation of foundation conditions beneath Folsom Dam *Jose Llopis*	Bioengineering slope stabilization techniques coupled with traditional engineering applications - The result a stable slope *Bethany Bearmore*	Break in Exhibit Hall	TRACK 6 Session 6F	Shoreline armor stone quality issues *Joseph Kissane*	Mill Creek - An urban flood control challenge *Monica Greenwell*	Next stop, The Twilight Zone *Troy O'Neal*
Room 228	TRACK 7 Session 7E	The geotechnical and structural issues impacting the Dalles spillway construction *Kristie Hartfeil*	The Dalles spillway engineering and design *Kristie Hartfeil*	The future of the discrete element method in infrastructure analysis *Raju Kala*	Break in Exhibit Hall	TRACK 7 Session 7F	Evaluating the portable falling weight deflectometer as a low-cost technique for posting seasonal load restrictions on low volume payments *Maureen Kestler*	Soil structure interaction effects in the seismic evaluation of success dam control tower *Michael Sharp*	Olmsted locks and Dam project geotechnical/construction issues *Jeff Schaefer*
Room 229	TRACK 8 Session 8E	Rubblization of airfield concrete pavement *Eileen Velez-Vega*	US Army airfield pavement assessment program *Haley Parsons*	Critical state for probabilistic analysis of levee underseepage *Douglas Crum*	Break in Exhibit Hall	TRACK 8 Session 8F	Curing practices for modern concrete construction *Toy Poole*	AAR at Carters Dam, a different approach *James Sanders*	Concrete damage at Carters Dam, GA *Toy Poole*

12 Noon **Lunch**

Room	Track / Session	1:30 PM	2:00 PM	2:30 PM	3:00 PM	Track / Session	3:30 PM	4:00 PM	4:30 PM
Room 226	TRACK 5 Session 5G	Slope stability evaluation of the Baldhill Dam right abutment *Neil Schwanz*	Lateral pile load test results within a soft cohesive foundation *Richard Varuso*	Design and construction of anchored bulheads for river diversion, Seabrook, NH *Siamac Vaghar*	Break	TRACK 5 Session 5H	Characterization of soft marine clays - A case study at Craney Island *Aaron Zdinak*	50 years of NRSC experience with engineering problems caused by dispersive clays *Danny McCook*	Changes in the post-tensioning institutes new (4th Ed. 2004) "Recommendations for prestressed rock and soil anchors" *Michael McCray*
Room 227	TRACK 6 Session 6G	Perils in back analysis failures *Greg Yankey*	Reconstruction of deteriorated lock walls concrete after blasting and other demolition removal techniques *Steve O'Connor*	Flood fighting structures demonstrations and evaluation program *George Sills*	Break	TRACK 6 Session 6H	Innovative design concepts incorporated into a landfill closure and reuse design *Dave Ray*	Laboratory testing of flood fighting structures *Johannes Wibowo*	Bluff stabilization along Lake Michigan using active and passive dewatering techniques *Eileen Glynn*
Room 228	TRACK 7 Session 7G	Geotechnical instrumentation and foundation re-evaluation of John Day lock and Dam, Columbia River, Oregon-Washington *David Scofield*	A study of the long term performance of seepage cutoff barriers in dams *John Rice*	Design, construction, and performance of seepage barriers for Guanella Dam, near Empire, CO *John France*	Break	TRACK 7 Session 7H	Sensitive infrastructure sites and structures - Sonic drilling offers quality control and non-destructive advantages to geotechnical construction drilling *John Davis*	Subgrade failure criteria according to soil type and moisture condition *Edel Cortez*	The automated stability monitoring of the Mississippi River levees using the range scan system *Robert Jolissian*
Room 229	TRACK 8 Session 8G	Damaging interactions among concrete materials *Toy Poole*	Economic effects on construction of uncertainty in test methods *Toy Poole*	Major issues in materials specifications *Toy Poole*	Break	TRACK 8 Session 8H	Spall and intermediate-sized repairs for PCC pavements *Reed Freeman*	Acceptance criteria for unbonded aggregate road surfacing materials *Reed Freeman*	Effective partnering to overcome an interruption in the supply of Portland cement during construction of Marmet lock and Dam *Billy Neeley*

Thursday, August 4, 2005 Concurrent Sessions

Geotechnical, Specifications, Electrical & Mechanical Engineering & Construction Tracks

Room	Track	8:00 AM	8:30 AM	9:00 AM	9:30 AM	Track	10:30 AM	11:00 AM	11:30 AM
Room 225	**TRACK 9 Geotechnical** Session 9E	Seepage Committee Meeting *GROUP DISCUSSION*	Seepage Committee Meeting (Continued) *GROUP DISCUSSION*	Seepage Committee Meeting (Continued) *GROUP DISCUSSION*	Break in Exhibit Hall	**TRACK 9 Geotechnical** Session 9F	GMCoP Forum *GROUP DISCUSSION*	GMCoP Forum (Continued) *GROUP DISCUSSION*	GMCoP Forum (Continued) *GROUP DISCUSSION*
Room 232	**TRACK 21 Specifications** Session 21E	SpecsIntact-Demonstration of the SI explorer, publishing to PDF and Word *Patricia Robinson*	SpecsIntact - Demonstration of the SI editor, UMRL and reference wizard *Patricia Robinson*	UFGS status and direction *Jim Quinn*		**TRACK 21 Specifica-tions** Session 21F	UFGS transitin to Master-Format 2004 *Carl Kersten*	Project specifications for the upper tier Folsom outlet works modifications *Steve Freitas*	UFGS dredging *Don Carmen*
Room A	**TRACK 15 Military Electrical** Session 15E	Electronic Security *Tri-Service Panel*	Electronic Security (Continued) *Tri-Service Panel*	AIRFIELD lightning protection & grounding and lighting *Tri-Service Panel*		**TRACK 15 Military Electrical** Session 15F	Electrical safety and arc flash UFC *Tri-Service Panel*	Electrical safety and arc flash UFC (Continued) *Tri-Service Panel*	Electrical infrastructure in Iraq - Restore Iraqi electricity *Joseph Swiniarski*
Room B	**TRACK 16 Military Mechanical** Session 16E	Lon works technology update *David Schwenk*	BACnet Technology Update *David Schwenk*	Implementation of Lon-based specifications *Will White*		**TRACK 16 Military Mechanical** Session 16F	Prefabricated Chiller Plants *Trey Austin*	Seismic for ME systems *Greg Stutts*	Design considerations for the prevention of mold *Quinn Hart*
Room D	**TRACK 17 Civil Mechanical** Session 17E	Lessons learned on flood water pump stations *Mark Robertson*	Armada of pump stations, Grand Forks and East Grand Forks *Timothy Paulus*	Various screen equipment selection guide *Sara Benier*		**TRACK 17 Civil Mechanical** Session 17F	Lock gate replacement system *Will Smith*	Lock gate replacement system (Continued) *Will Smith*	Automated closure gate design for Duck creek flood control *Mark Robertson*
Room 230	**TRACK 19 Construction** Session 19E	NAVFAC Construction scheduling *Glenn Saito*	NAVFAC Construction scheduling (Continued) *Glenn Saito*	ACASS/CASS - CPARS *Ed Marceau*		**TRACK 19 Construction** Session 19F	Self-consolidating concrete *Beatrix Kerhoff*	Self-consolidating concrete (Continued) *Beatrix Kerhoff*	
Room 231	**TRACK 20 Construction** Session 20E	Update on DAWIA and Facilities Engineering *Mark Grammer*	Update on DAWIA and Facilities Engineering (Continued) *Mark Grammer*	Partnering as a best practice *Ray DuPont*		**TRACK 20 Construction** Session 20F	S&A Update *Harry Jones*	Construction Issues Open Forum (Q&A) *Don Basham*	Construction Issues Open Forum (Q&A) (Continued) *Don Basham*

12 Noon — **Lunch**

Room	Track	1:30 PM	2:00 PM	2:30 PM	3:00 PM	3:30 PM	4:00 PM	4:30 PM
Room 225	**TRACK 9 Geotechnical** Session 9G	Seismic Manual *GROUP DISCUSSION*	Seismic Manual (Continued) *GROUP DISCUSSION*	Seismic Manual (Continued) *GROUP DISCUSSION*				

Thursday, August 4, 2005 Concurrent Sessions

Dam Safety Track & Structural Engineering Track

Room	Track	8:00 AM	8:30 AM	9:00 AM	9:30 AM	10:30 AM	11:00 AM	11:30 AM
Room 224	**TRACK 10** Dam Safety — Session 10E	Seepage and stability, final evaluation for reservoir pool raising project, Terminus Dam, Kaweah River, CA *Michael Ramsbotham*	Initial filling plan, Terminus dam spillway enlargement, Terminus Dam, Kaweah River, CA *Michael Ramsbotham*	Hydrologic aspects of operating in a "failure mode" - Fern Ridge Lake, OR *Bruce Duffe*	Break in Exhibit Hall	**TRACK 10** Dam Safety — Session 10F: A dam safety study involving cascading dam failures *Gordon Lance*		The relationship of seismic velocity to the erodibility index *Joseph Topi*
Room 240	**TRACK 12** Civil Works Structural — Session 12E	London lock and dam, West Virginia major rehabilitation project *David Sullivan*	Replacing existing lock 4-Innovative designs for Charleroi lock *Steveb Stoltz*	Use of non-linear incremental structural analysis in the design of the Charleroi lock *Randy James*	Break in Exhibit Hall	**TRACK 12** Civil Works Structural — Session 12F: Olmsted dam in-the-wet construction methods *Lynn Raque*	Completion of the Olmstead approach walls *Terry Sullivan*	John Day lock monolith repair *Mathew Hanson*
Room 241	**TRACK 13** Civil Works Structural — Session 13E	Chicago shoreline project *Jan Plachta*	Structural assessment of Bluestone Dam *Robert Reed*	Duck Creek, OH local flood protection projection phase III Culvert damage *Jeremy Nichols*	Break in Exhibit Hall	**TRACK 13** Civil Works Structural — Session 13F: Development of design criteria for the Rio Puerto Nuevo contract 2D/2E channel wall *Jana Tanner*	Design of concrete lined tunnels in rock *David Force*	Indianapolis north phase IIIA project *Gene Hoard*
Room 242	**TRACK 14** Bridges/ Buildings — Session 14E	Urban search & rescue program overview *Tom Niedernhofer*	Evaluation and repair of blast damaged reinforced concrete beams *John Hudson*	Single degree of freedom blast effects spreadsheets *Dale Nebuda*	Break in Exhibit Hall	**TRACK 14** Bridges/ Buildings — Session 14F: UFC 4-023-02 Structural design to resist explosive effects for existing buildings *Jim Caulder*	Progressive collapse UFC requirements *Brian Crowder*	U.S. general services admnistrative progressive collapse design guidelines applied to concrete moment-resisting frame buildings *David Billow*

12 Noon **Lunch**

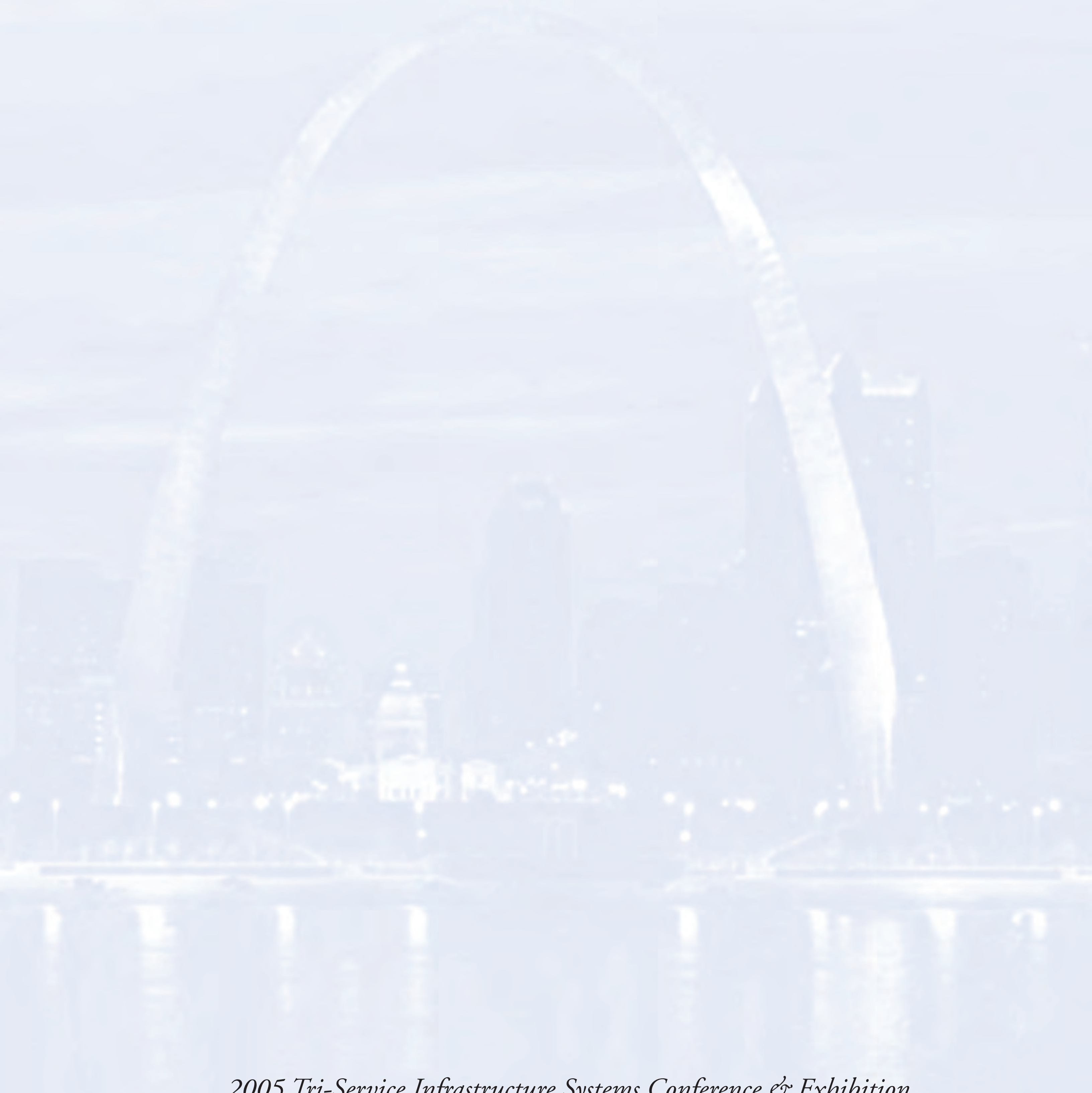
Room	Track	1:30 PM	2:00 PM	2:30 PM	3:00 PM	3:30 PM	4:00 PM	4:30 PM
Room 224	**TRACK 10** Dam Safety — Session 10G	Dam safety instrumentation data management utilizing WinIDP to aid data collection and evaluation *Travis Tutka*	Automated instrumentation assessments at Marmet lock & Dam *Ronald Rakes*	Potential failure mode analysis of Eau Galle Dam *David Rydeen*	Break	**TRACK 10** Dam Safety — Session 10H: Dam safety officers panel - The Good *Bruce Murray*	Dam safety officers panel - The Bad *Bruce Murray*	Dam safety officers panel - The Ugly *Bruce Murray*
Room 240	**TRACK 12** Civil Works Structural — Session 12G	Inner Harbor navigation canal and lock structure *Mark Gonski*	Design features and challenges of the Comite River diversion project *Christopher Dunn*	Waterline support failure on the Harvey canal: A case study *Angela DeSoto Duncan*	Break	**TRACK 12** Civil Works Structural — Session 12H: Public appeal of major civil projects- The good, the bad and the ugly *Kevin Holden*	Des Moines Riverwalk *Thomas Heinold*	Chickamauga lock and Dam height optimization study using Monte Carlo simulation *Leon Schieber*

Thursday, August 4, 2005 Concurrent Workshops

Room	Workshop	1:30 PM	2:00 PM	2:30 PM	3:00 PM	Workshop	3:30 PM	4:00 PM	4:30 PM
Room 241	**Workshop 1** DoD Security Engineering **Session 1A**	Security planning & minimum standards *Curt Betts*	Security planning & minimum standards (Continued) *Curt Betts*	Security planning & minimum standards (Continued) *Curt Betts*	Break	**Workshop 1** DoD Security Engineering **Session 1B**	Security design manuals *Bernie Deneke*	Security design manuals (Continued) *Bernie Deneke*	Security design manuals (Continued) *Bernie Deneke*
Room 231	**Workshop 2** Electrical Workshop **Session 2A**	National Electrical Code 2005 Changes *Mark McNamara*	National Electrical Code 2005 Changes (Continued) *Mark McNamara*	National Electrical Code 2005 Changes (Continued) *Mark McNamara*	Break	**Workshop 2** Electrical Workshop **Session 2B**	National Electrical Code 2005 Changes (Continued) *Mark McNamara*	National Electrical Code 2005 Changes (Continued) *Mark McNamara*	National Electrical Code 2005 Changes (Continued) *Mark McNamara*
Room 242	**Workshop 3** Mechanical Engineering **Session 3A**	Design and application of packaged central cooling plants *The Trane Company*	Design and application of packaged central cooling plants (Continued) *The Trane Company*	Design and application of packaged central cooling plants (Continued) *The Trane Company*	Break	**Workshop 3** Mechanical Engineering **Session 3B**	Improving dehumidification in HVAC systems *The Trane Company*	Improving dehumidification in HVAC systems (Continued) *The Trane Company*	Improving dehumidification in HVAC systems (Continued) *The Trane Company*
Room 230	**Workshop 4** Construction **Session 4A**	Construction Community of Practice Forum *Walt Norko*	Construction Community of Practice Forum (Continued) *Walt Norko*	Construction Community of Practice Forum (Continued) *Walt Norko*	Break				
Room 232	**Workshop 5** Specifications **Session 5A**	Open Meeting of Corps Specifications Steering Committee *Robert Iseli, et al.*	Open Meeting of Corps Specifications Steering Committee (Continued) *Robert Iseli, et al.*	Open Meeting of Corps Specifications Steering Committee (Continued) *Robert Iseli, et al.*	Break	**Workshop 5** Specifications **Session 5B**	Open Meeting of Corps Specifications Steering Committee (Continued) *Robert Iseli, et al.*	Open Meeting of Corps Specifications Steering Committee (Continued) *Robert Iseli, et al.*	Open Meeting of Corps Specifications Steering Committee (Continued) *Robert Iseli, et al.*

NOTES

NDIA
NATIONAL DEFENSE INDUSTRIAL ASSOCIATION
STRENGTH THROUGH INDUSTRY & TECHNOLOGY



2005 Tri-Service Infrastructure Systems Conference & Exhibition
"Re-Energizing Engineering Excellence"
August 2-4, 2005
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Tri-Service Infrastructure Systems Conference & Exposition
St. Louis, MO - August 2005

GSA Progressive Collapse Design Guidelines Applied to Concrete Moment-Resisting Frame Buildings

David N. Bilow, P.E., S.E. and
Mahmoud E. Kamara, PhD
Portland Cement Association

Topics

- Definition
- Comparison of DOD & GSA requirements
- Purpose of PCA study
- Study procedure
- Results

Ronan Point (1968)

- Explosion on 18th floor
- Wall panel blown out
- 22 floors collapse

Ronan Point

Prevent Progressive Collapse

- Explosion at ground floor
- Local damage only

GSA and DOD Criteria Comparison

Requirement	GSA	DOD
Level of Protection (LOP)	Exempt or nonexempt	Very Low, Low, Medium, and High
Tie Requirements	Redundancy, ductility & continuity	Vertical and/or horizontal tie forces, and ductility
Alternate Path Analysis	Required for nonexempt	Req'd for Low LOP w/o vertical tie, Medium LOP, & High LOP
Column Removal	Middle of long side, middle of short side, & corner column, <u>at ground level only</u>	Middle of long side, middle of short side, & corner column, <u>at each floor one at a time</u>

Comparison

Requirement	GSA	DOD
Loads for Static Analysis	2(DL +0.25LL) all bays and floors	2.0(1.2DL + 0.5LL) + 0.2W Adjacent bays & floor above 1.2 DL + 0.5LL for rest of structure
Loads for Dynamic Analysis	DL + 0.25LL	1.2DL + 0.5LL + 0.2W
Upward Loads on Floor Slabs	Recommended	1.0DL + 0.5LL
Method of Analysis	Linear static preferred	Linear static, nonlinear static, or nonlinear dynamic

Comparison

Requirement	GSA	DOD
Material Strength Increase Factor	1.25	1.25
Strength Reduction Factor, ϕ	1	ϕ specified in ACI 318
Acceptance Criteria	DCR $\leq$ 2.0 for typical structures	Allow plastic hinges & moment redistribution
Maximum Extent of Floor Collapse	Exterior: 1800 ft^2 Interior: 3600 ft^2	Exterior: 1500 ft^2 or 15% Interior: 3000 ft^2 or 30%

PCA Study Objectives

1. Determine how to apply the GSA progressive collapse guidelines.
2. Determine additional reinforcement needed to meet requirements for reinforced concrete frame buildings.

References

- General Services Administration

  Progressive Collapse

  Analysis and Design Guidelines for

  New Federal Office Buildings and

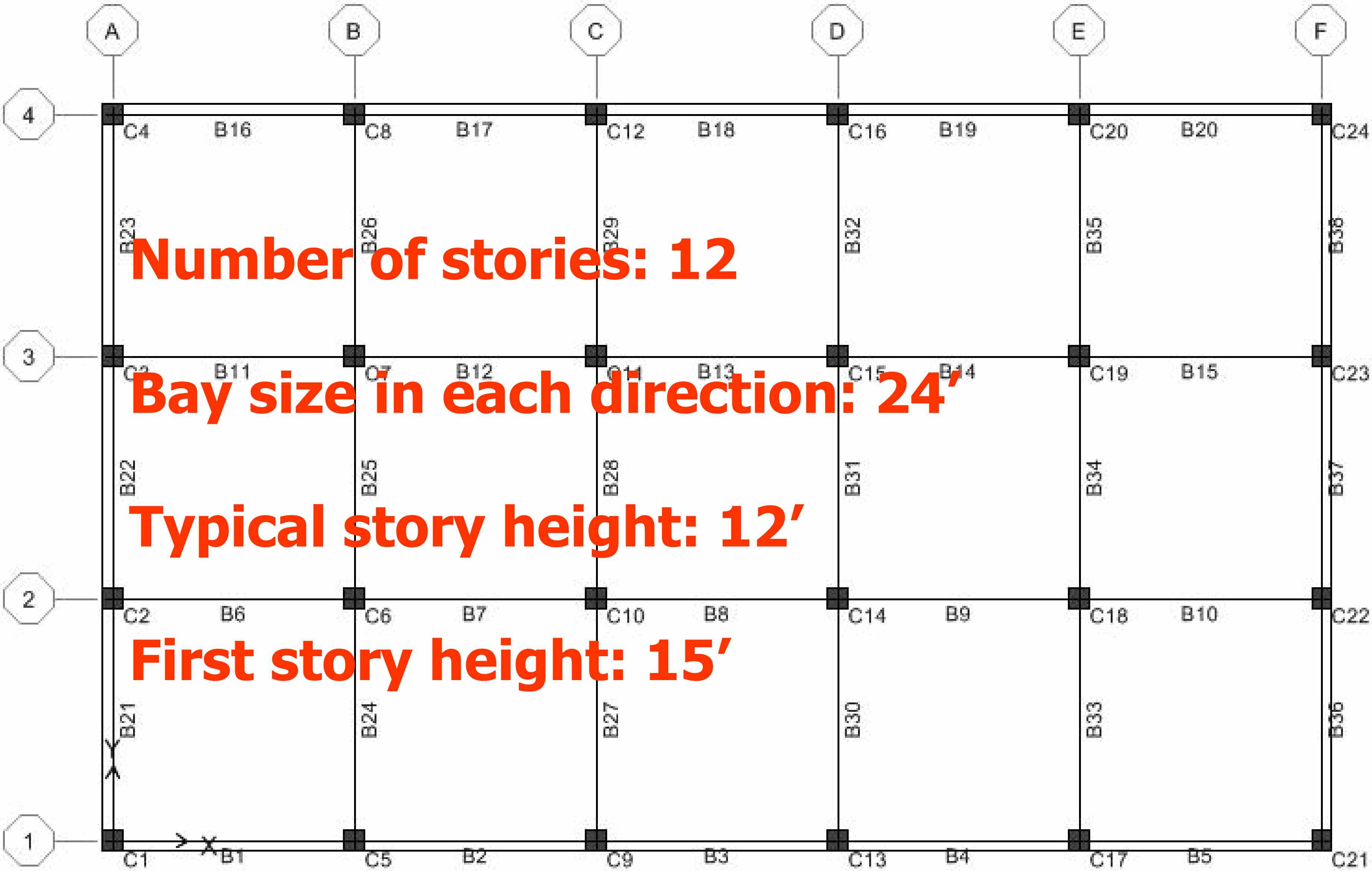
  Major Modernization Projects

  June 2003
- 2000 International Building Code
- ACI 318-99 Building Code Requirements for Structural Concrete

Study Procedure

1. Design 3 building structures for live, dead, wind, and seismic loads
2. Instantaneously remove selected first floor columns
3. Calculate the alternate path loads per GSA criteria
4. Apply the GSA loads to the structure
5. Determine moments and forces
6. Determine ultimate unfactored member capacity
7. Calculate Demand Capacity Ratios
8. Calculate additional reinforcement

Building Plan



Number of stories: 12

Bay size in each direction: 24′

Typical story height: 12′

First story height: 15′

Loads

- Floor Live Load = 50 psf
- Superimposed Dead Load = 30 psf
- Dead Load
- Wind Load for 70 MPH
- Seismic Load - 3 Locations

Three Reinforced Cast-in-Place Concrete Moment Frame Buildings

Seismic Design Class	Short Period Acceleration	Type of Detailing
A	.024g	Ordinary moment frame
C	.094g	Intermediate moment frame
D	.61g	Special moment frame

Load Combinations

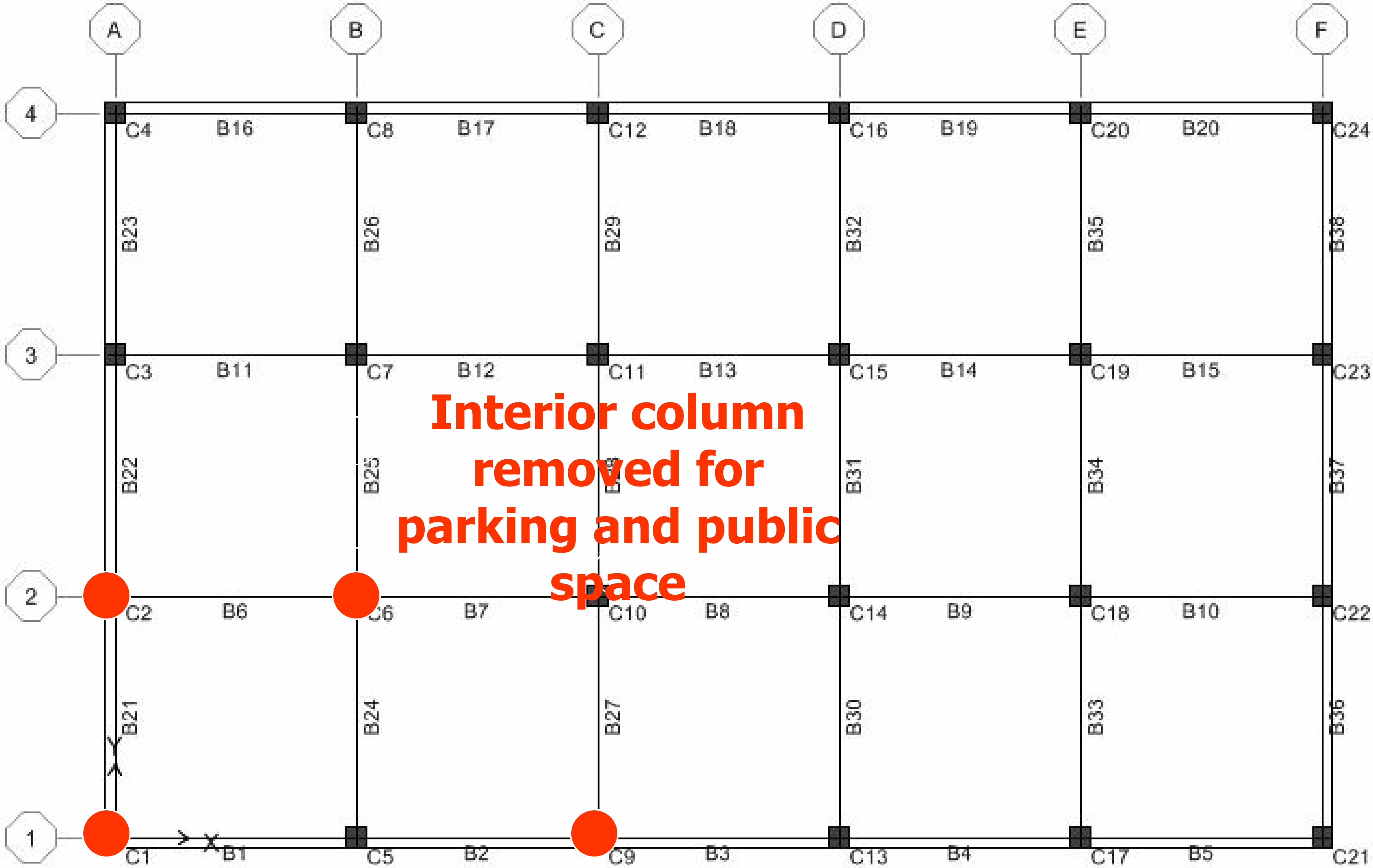
Normal Loading

- U = 1.4D + 1.7L
- U = 0.75(1.4D + 1.7L+ 1.7W)
- U = 0.75(1.4D +1.7L +1.1 E)

Analysis and Design

- Select preliminary member sizes
- Model in 3 dimensions
- Static linear elastic analysis
- Beam and column reinforcement calculated
- ETABS software version 8.11

Remove 1st Story Columns



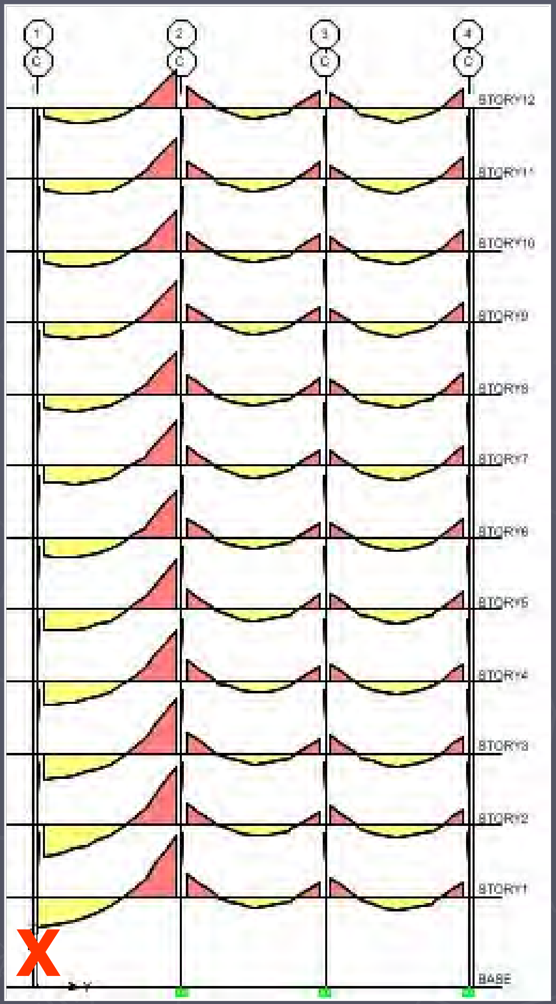
Alternate Load Path Analysis

- Four new models of each of 3 buildings
- First story columns removed

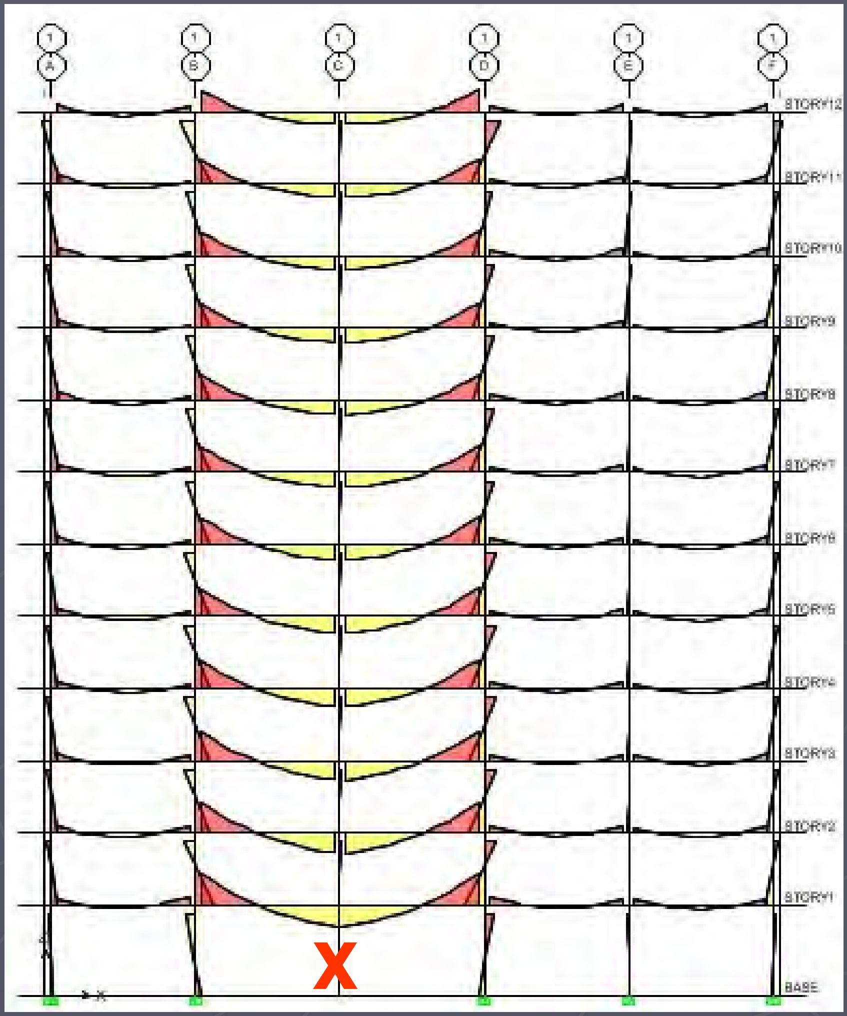
Progressive Collapse Alternate Load Path

- Gravity Load = 2(DL+0.25LL)
- Determine forces and moments (ETABS)

Bending Moments



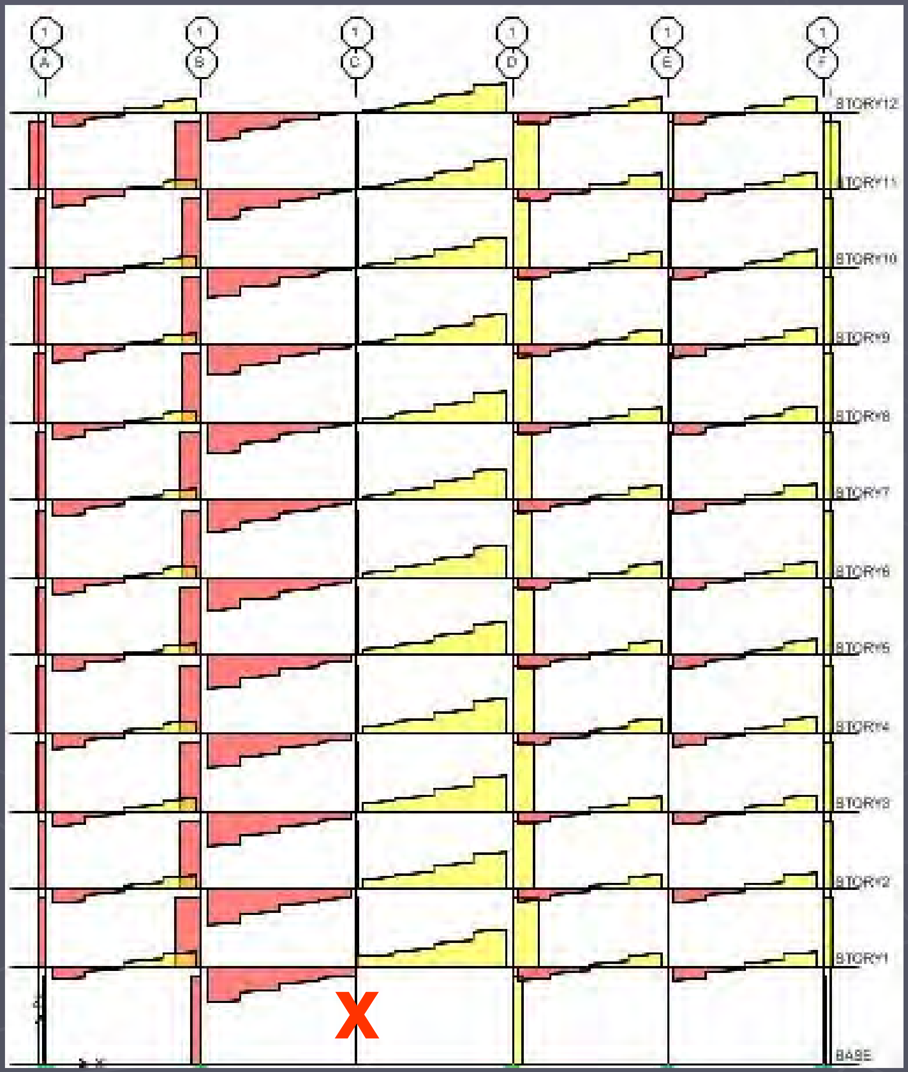
After Removing Corner Column



After Removing Long Side Center Column

Shear Forces

After Removing Long Side Center Column



Calculate Demand Capacity Ratios

$DCR = Q_{UD}/Q_{CE}$

Q_{UD}: Acting force from alternate load path

Q_{CE}: Ultimate unfactored component capacity with strength increased 25%

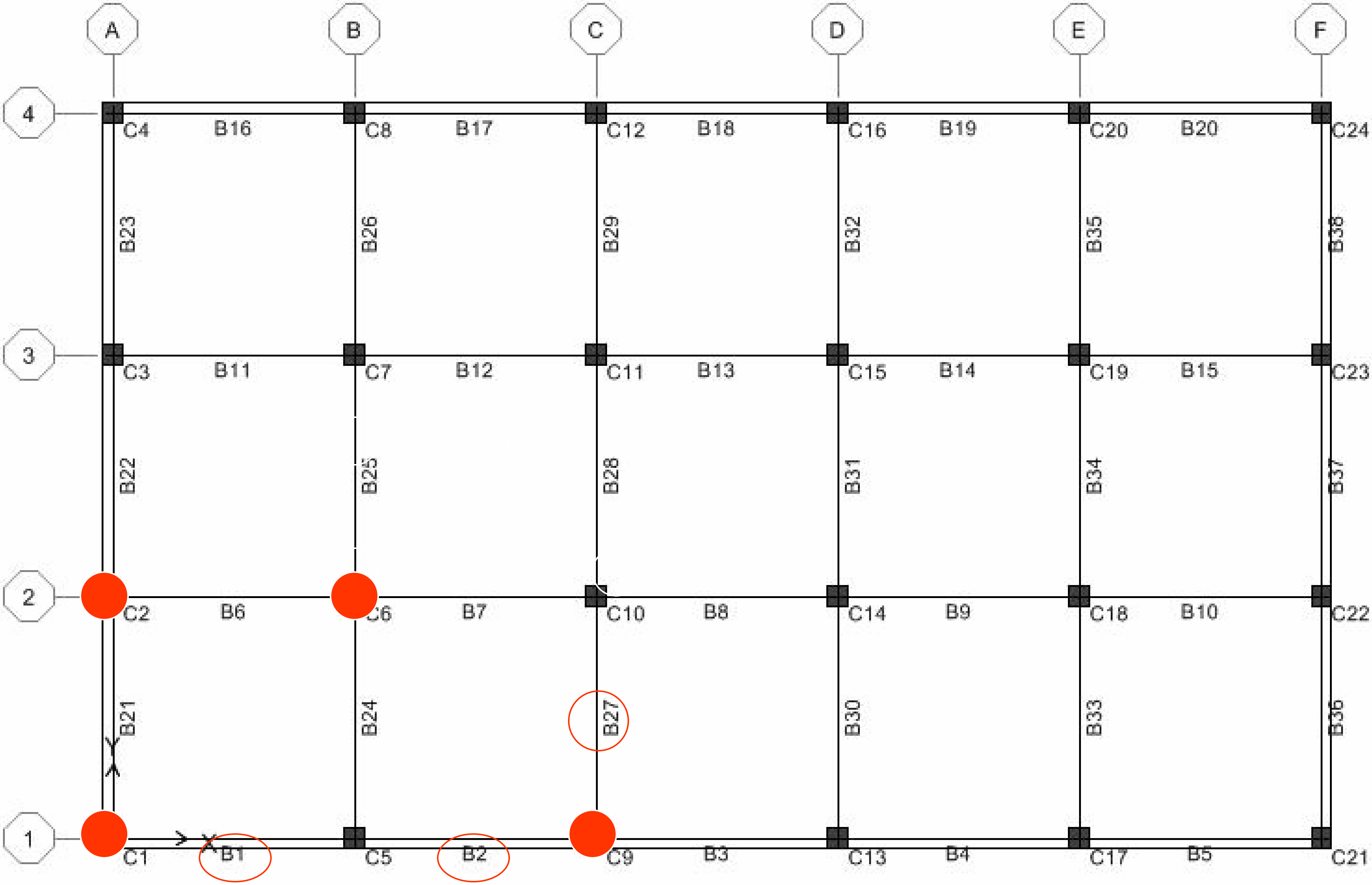
Limits:

DCR < 2.0 for typical structures

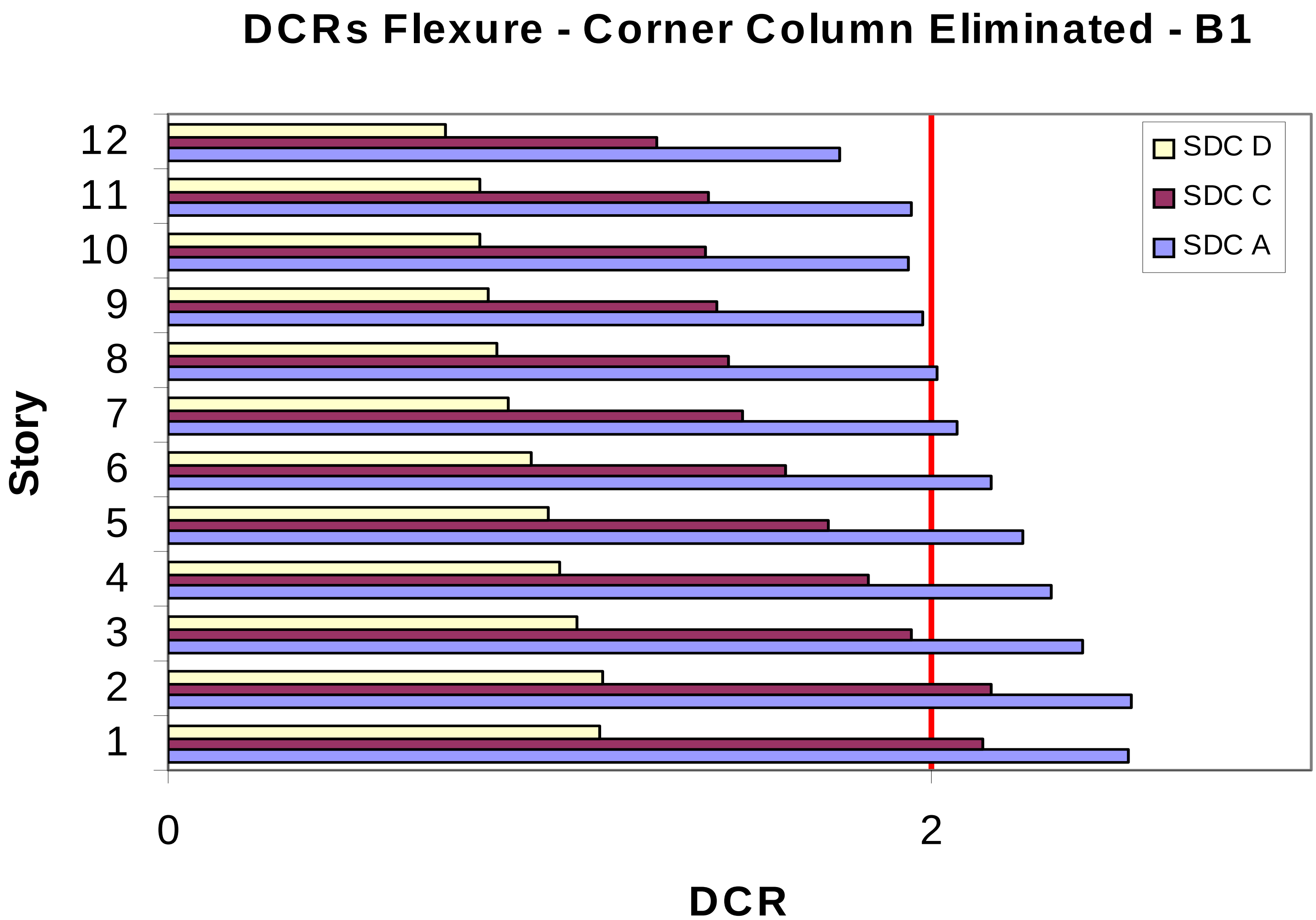
DCR < 1.5 for atypical structures

NEHRP Guidelines for Seismic Rehabilitation of Buildings- FEMA 1997

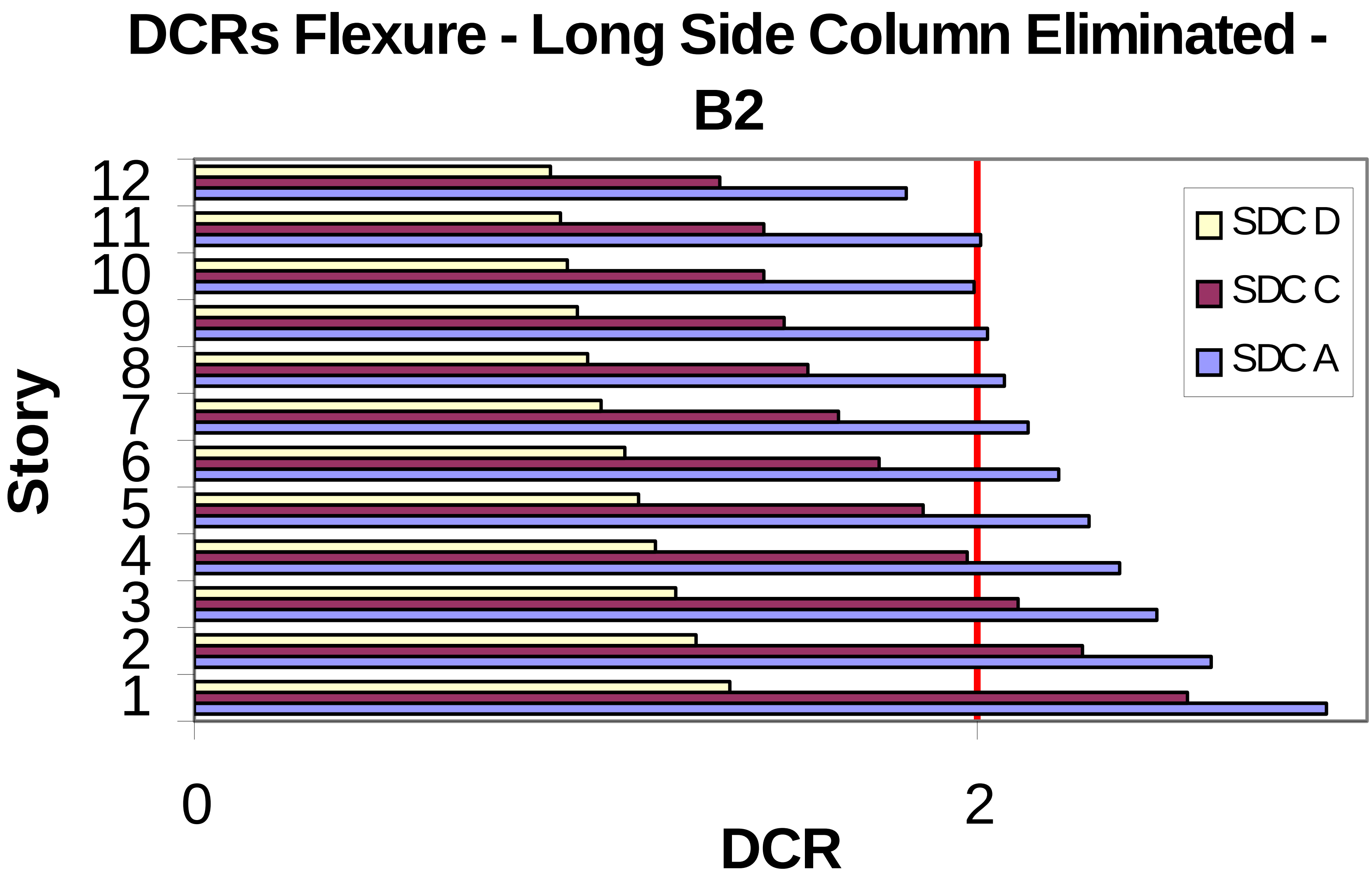
Remove 1st Story Columns



Study Results

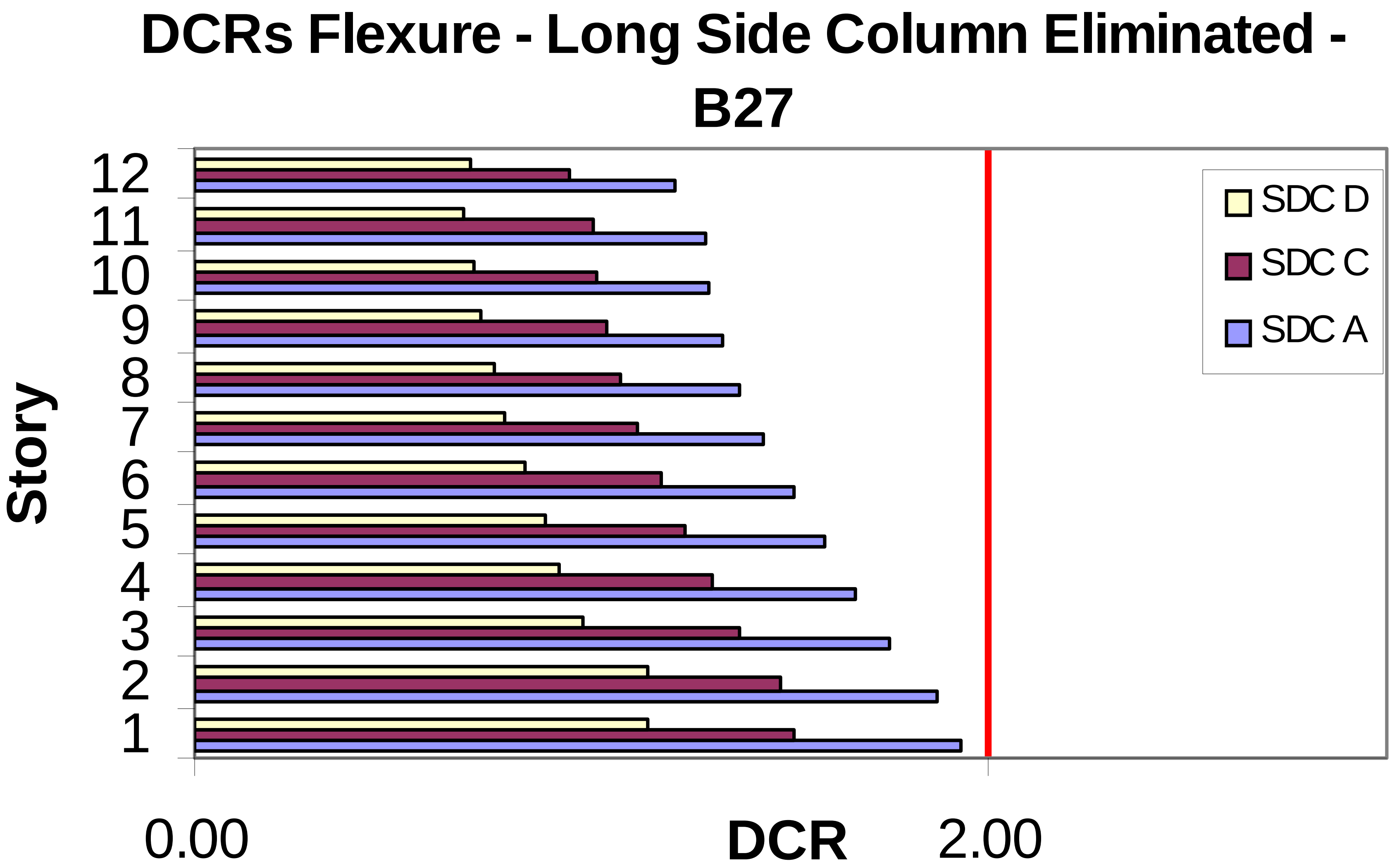


Results



DCRs Flexure - Long Side Column Eliminated - B2
Story
12
11
10
9
8
7
6
5
4
3
2
1
0
2
DCR
SDC D
SDC C
SDC A

Results

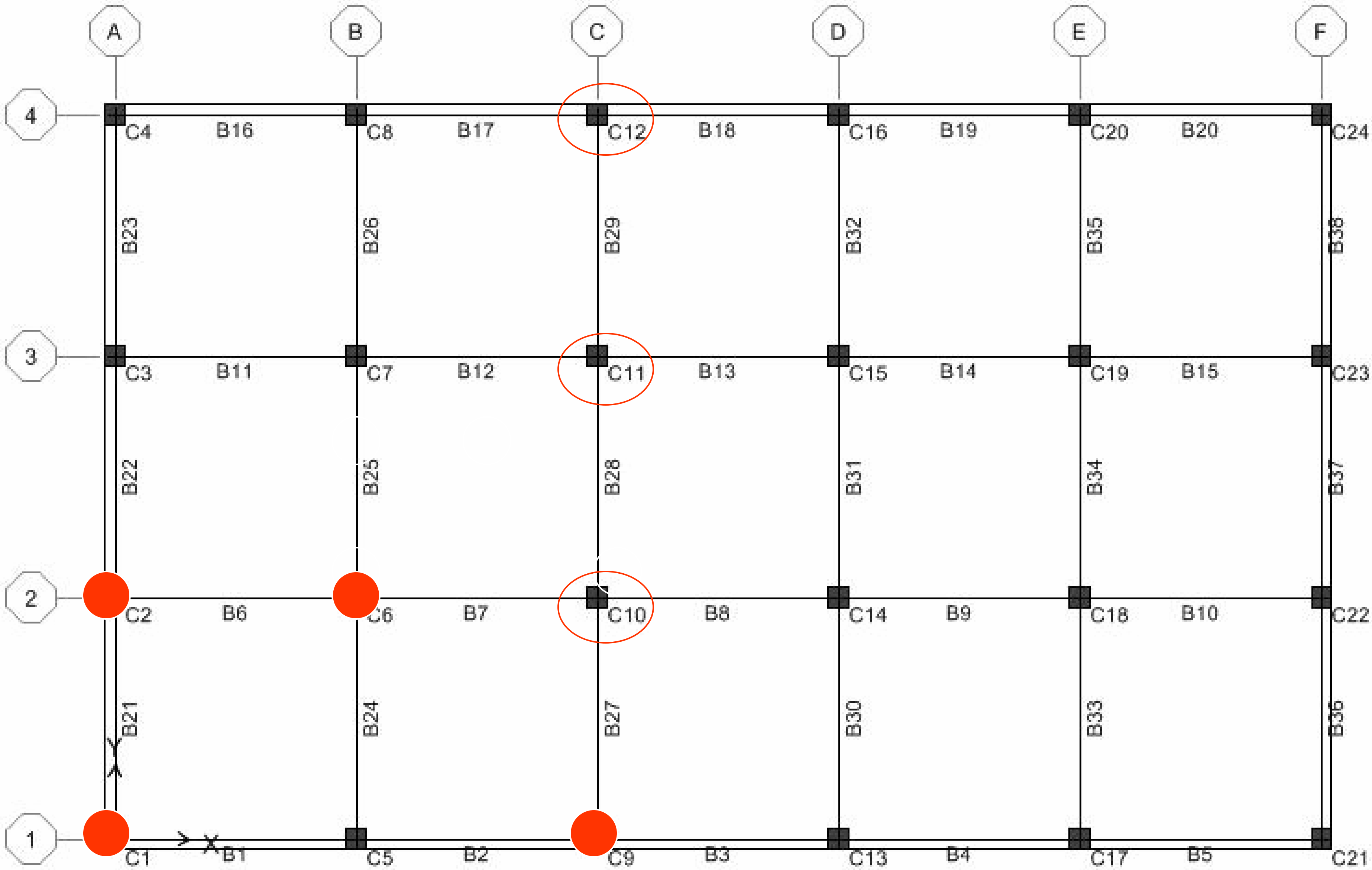


DCRs Flexure - Long Side Column Eliminated - B27
Story
12
11
10
9
8
7
6
5
4
3
2
1
0.00
DCR
2.00
SDC D
SDC C
SDC A

DCR for Shear in Beams

Story	B2	B27
11	1.17	.79
9	1.19	.81
7	1.23	.86
5	1.32	.94
3	1.39	1.01
1	1.46	1.04

Remove 1st Story Columns



DCR for 1st Story Columns

Column	Seismic Class A	Seismic Class C	Seismic Class D
C9	X	X	X
C10	1.23	.88	.73
C11	1.02	.76	.59
C12	.84	.65	.44

Summary of Results

Item	Number	DCR Value	Action
Shear	All	< 2.0	None
Columns	All	< 2.0	None
Beams, Class D	All	< 2.0	None
Beams, Class C	55 of 456	> 2.0	Add Rebar
Beams, Class A	235 of 456	> 2.0	Add Rebar

Additional rebar for “A” Structures

Cost = $12,000

Conclusion

Applying the GSA criteria to prevent progressive collapse for concrete buildings can be accomplished by the structural engineer using readily available software and for little additional construction cost.

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Headquarters U.S. Air Force

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UFC 4-023-02
Retrofit of Existing Buildings to Resist Explosive Effects

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August 2005

U.S. AIR FORCE

UFC 4-023-02
Retrofit of Existing Buildings to Resist Explosive Effects

JIM CAULDER, P.E.
HQ AFCESA/CESC

August 2005

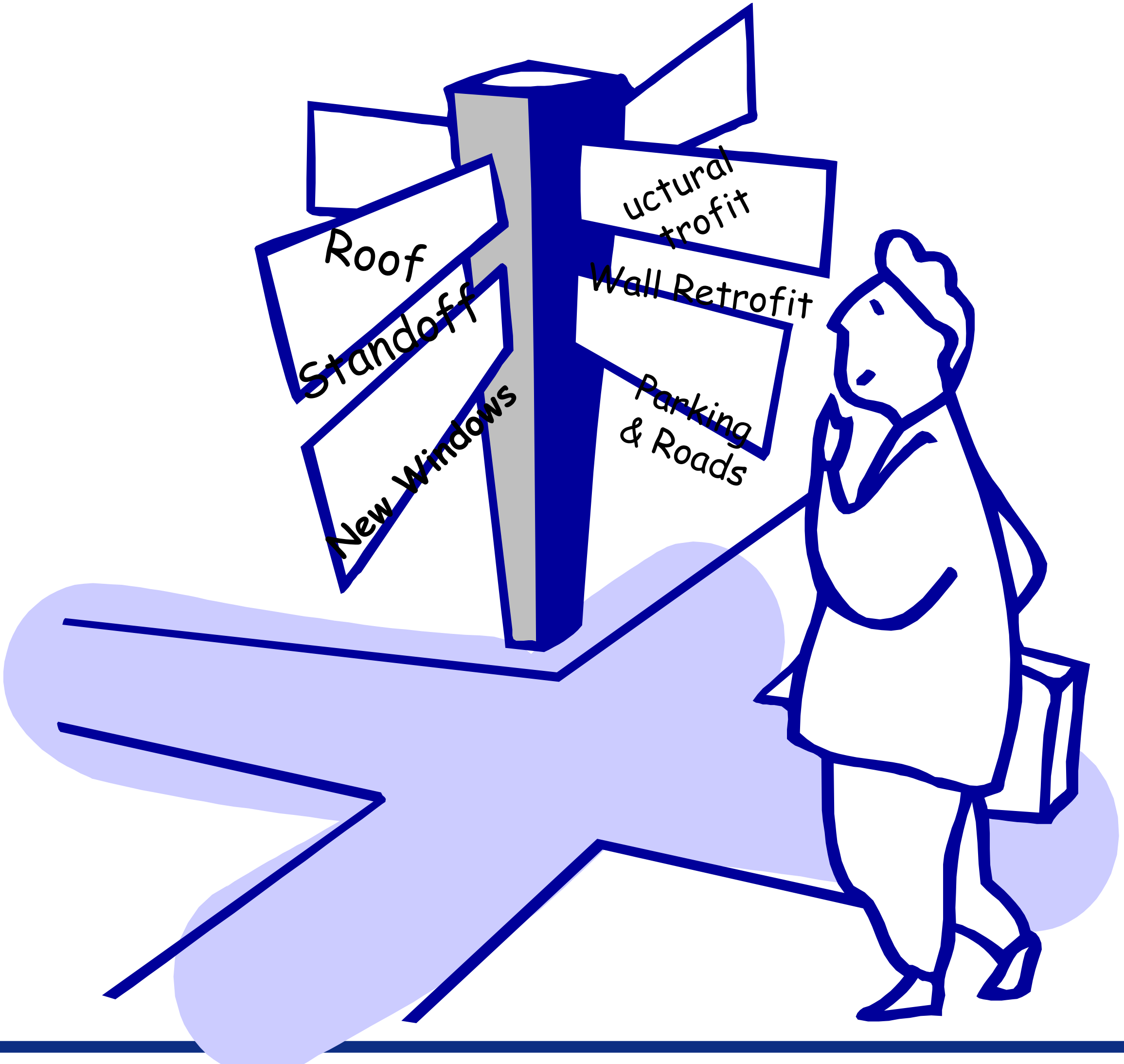
U.S. AIR FORCE

Overview

- UFC 4-023-02 ***Security Engineering: Structural Design to Resist Explosive Effects for Existing Buildings***

  - **Design and analysis of various retrofit approaches**
  - **Covers mostly wall retrofits; some information on columns, roofs**
  - **Windows will be covered in UFC 4-013-04**
  - **Summarizes the published results of DoD-sponsored research into blast mitigation**
    - Often retrofit techniques based on **very limited** data, and therefore conservative

Philosophy of Retrofit for Blast

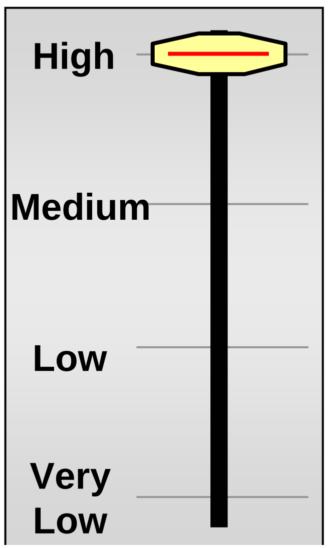


Balanced Design

- Goal of blast protection retrofits = Increased Level of Protection (LOP)
  - #1 Objective = Prevent structural collapse
  - #2 Objective = Prevent injury from flying debris
- Design should be "balanced" among various building elements

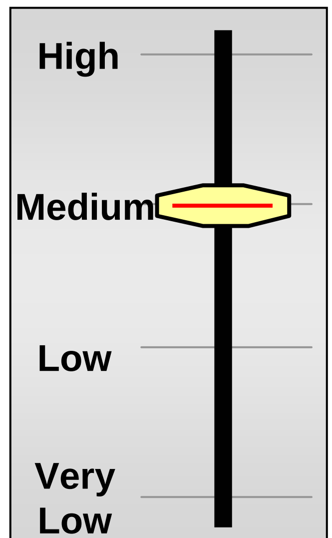
Balanced Design, continued

Primary Structure
(Collapse Hazard)



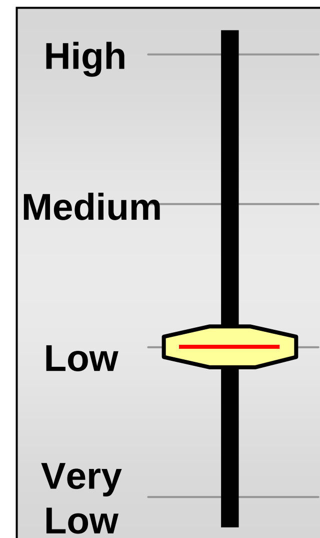
Columns, beams, roof, slabs and bearing walls

Secondary Structure
(Debris Hazard)



Non-load bearing walls and supports

Openings
(Debris Hazard)



Doors, windows and vents

Levels of Protection (LOPs)

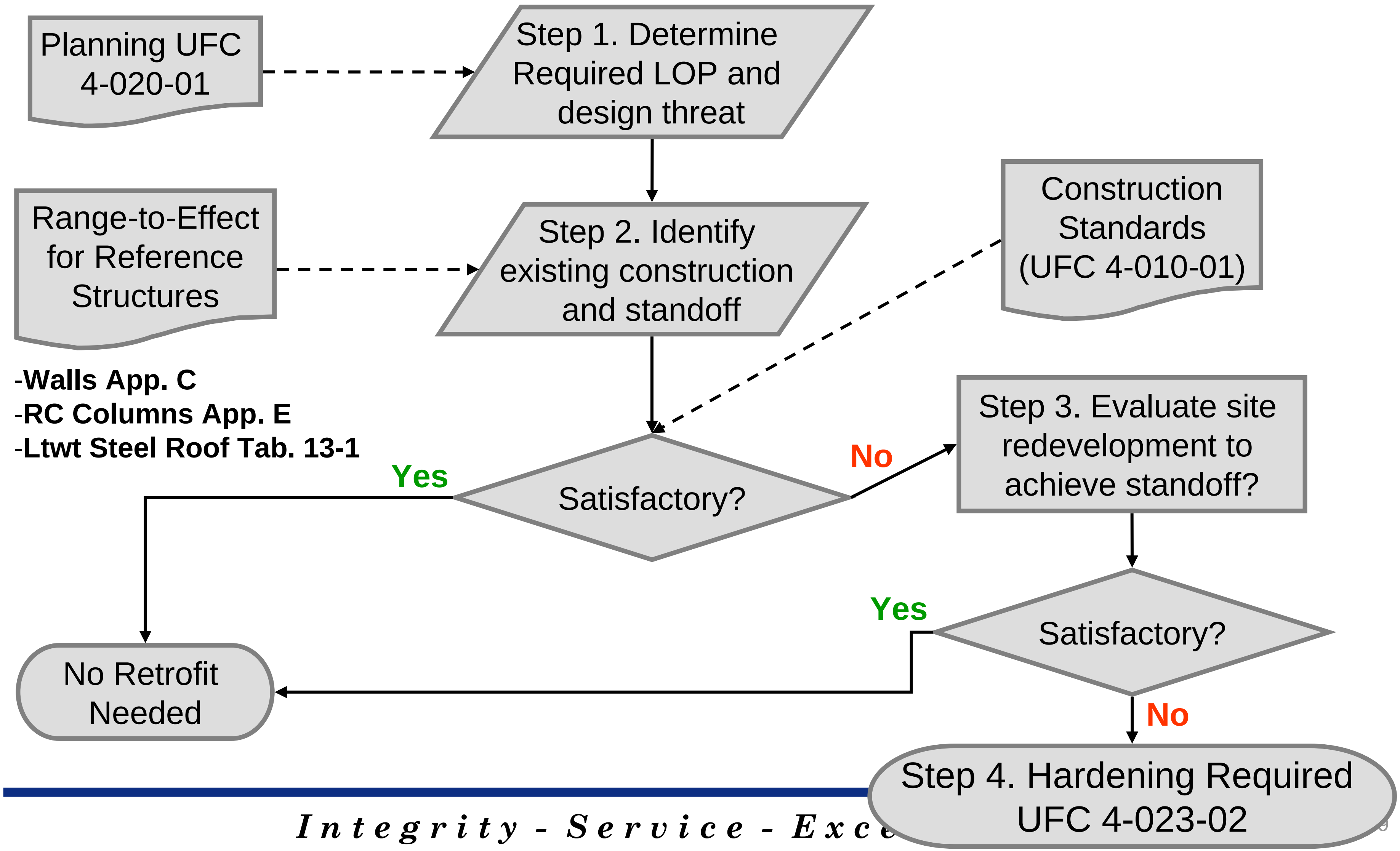
Level of Protection	Potential Wall Damage	Potential Injury
Below AT Standards	**Collapse of primary structural elements**	**Fatalities near 100%**
Very Low	**Collapse of secondary structural elements**	**Fatalities 10 – 25%** **Majority seriously injured**
Low	**Damaged – unrepairable; major deformation of secondary structure**	**Fatalities < 10%** **Majority injured**
Medium	**Damaged – repairable; minor deformation of secondary structure**	**Some minor injuries**
High	**Superficial damage**	**Superficial injuries**

Retrofit Design Approach

- Determining the Need for a Retrofit
  - General Design Procedures
  - DoD Minimum Construction Standards
  - Reference Structures and Range-to-Effect

U.S. AIR FORCE

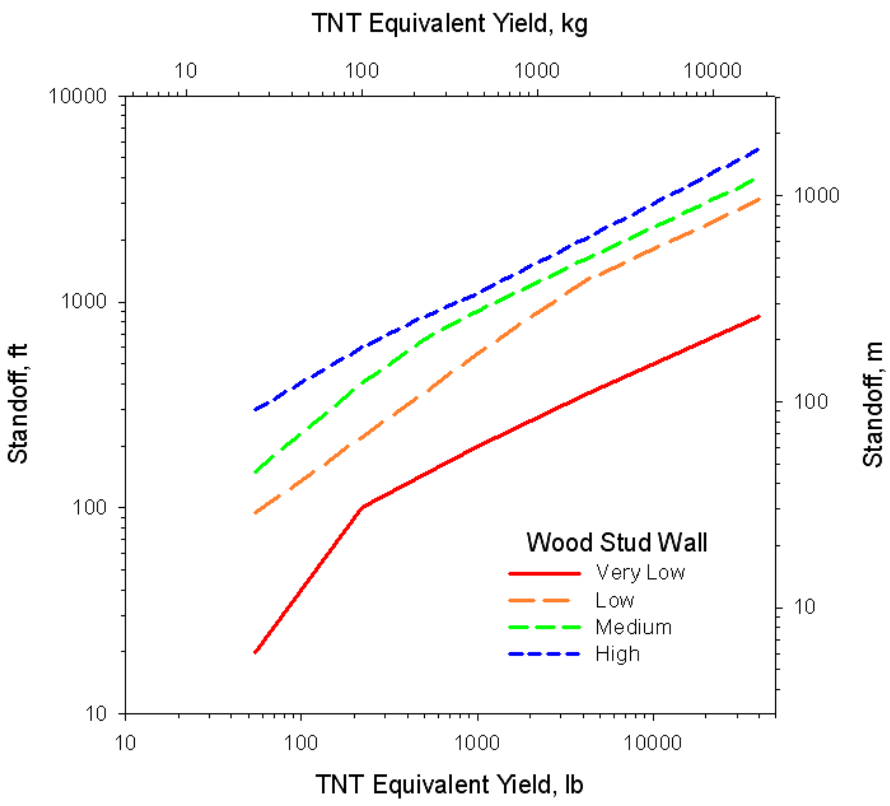
General Design Procedures



Reference Structures

- **UFC includes range-to-effect charts for 14 reference structure types**
  - **Table 2-1 describes structures, with emphasis on exterior wall construction**
  - **Appendix C contains wall range-to-effect charts**
- **User must "best fit" actual structures to one of these types**

Figure C-1. Range-to-Effect Chart for Wood Stud Wall.



Wood Stud

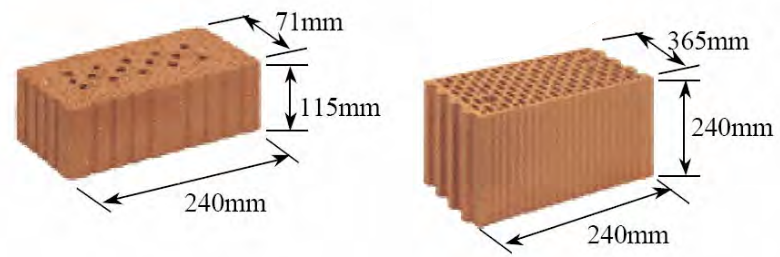
- One-story, wood stud walls, plywood sheathing (Fig. C-1)
- Two-story, wood stud load-bearing walls, plank sheathe siding (Fig. C-2)

Unreinforced Masonry

- One-story, unreinforced concrete masonry unit (CMU) infill walls (Fig. C-3)
- One-story, unreinforced CMU infill walls with all cells fully grouted (Fig. C-6)

Unreinforced European Brick

- **Two-story, unreinforced large format clay brick walls, load bearing (Fig. C-4)**
- **Two-story unreinforced standard format clay brick walls, load bearing (Fig. C-5)**



Standard Format Large Format

Large Format Brick Wall

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Reinforced Masonry

- One-story, reinforced concrete moment frame, lightly reinforced CMU infill walls (Fig. C-7)
- Two-story, steel frame, lightly reinforced CMU infill walls (Fig. C-8)

Reinforced Concrete

- **One-story, 150-mm (6-in) thick reinforced concrete load bearing walls (Fig. C-9)**
- **Two-story, 200-mm (8-in) thick reinforced concrete load bearing walls (Fig. C-10)**

Other Construction Types

- One-story, pre-engineered building, steel frame, sheet metal walls (Fig. C-11)
- Multi-story, steel frame, glazed curtain walls

  (Fig. C-12)

Expeditionary Structures

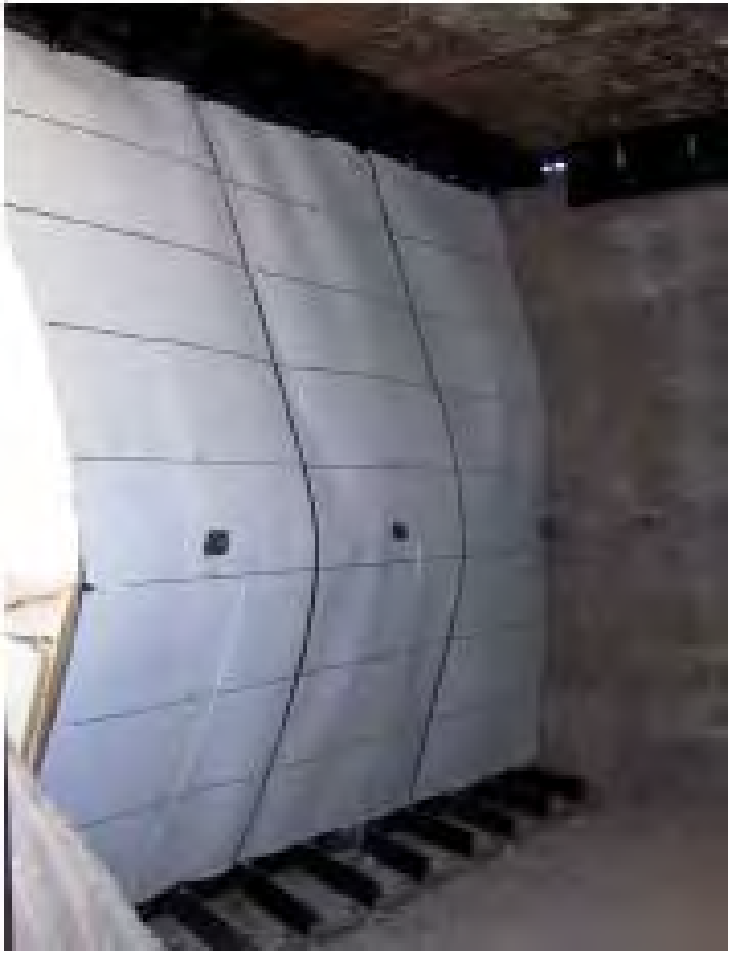
- One-story, expeditionary building, wood stud walls, plywood sheathing (Fig. C-13)
- One-story, expeditionary tent building, canvas duck walls, aluminum framing (Fig. C-14)

Organization of Wall Retrofit Techniques

- Eleven wall retrofit approaches (Chps. 3-13)
  - Description
  - Applicability
  - Testing
  - Level of Protection
  - Construction Details
- Table 2-2 summarizes key aspects
  - Organized roughly by wall type
    [all (2) – masonry (6) – stud (3)]
  - “Difficulty to Install” is subjective and relative indicator to help compare the eleven approaches

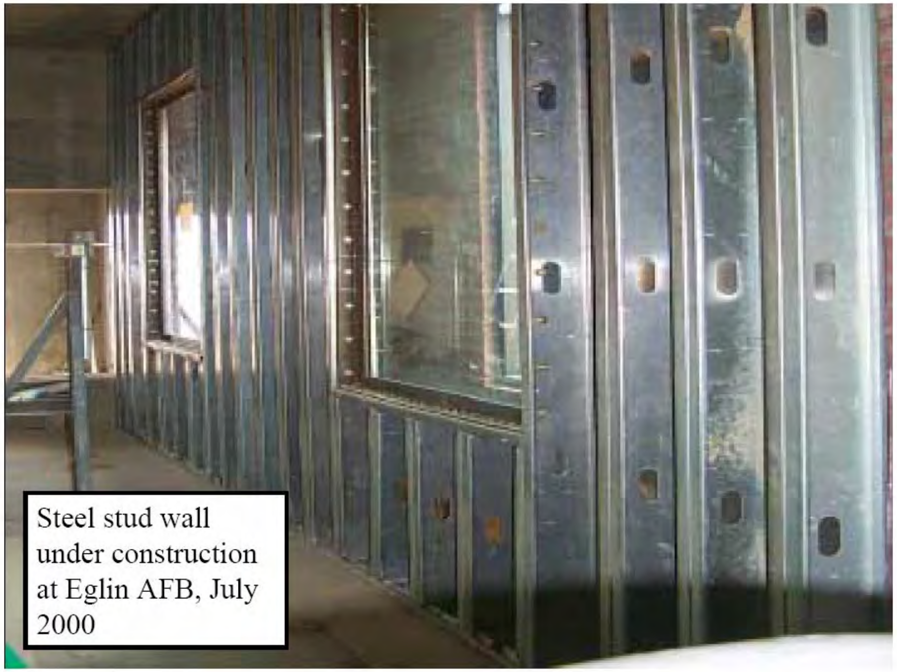
Thin Steel Plate Catcher System (Chap. 3)

- Steel plate anchored into frame with optional foam layer
- Applicable to all wall types
- Resulting LOP: Medium
- Installation Difficulty: Medium to High
- Load Bearing: No
- Windows: No



Steel Stud Wall / Window Retrofit (Chap. 4)

- Steel stud wall erected inside existing wall
- Applicable to all wall types with reinforced concrete frames
- Resulting LOP: Medium
- Installation Difficulty: Medium to High
- Load Bearing: Yes
- Windows: Yes



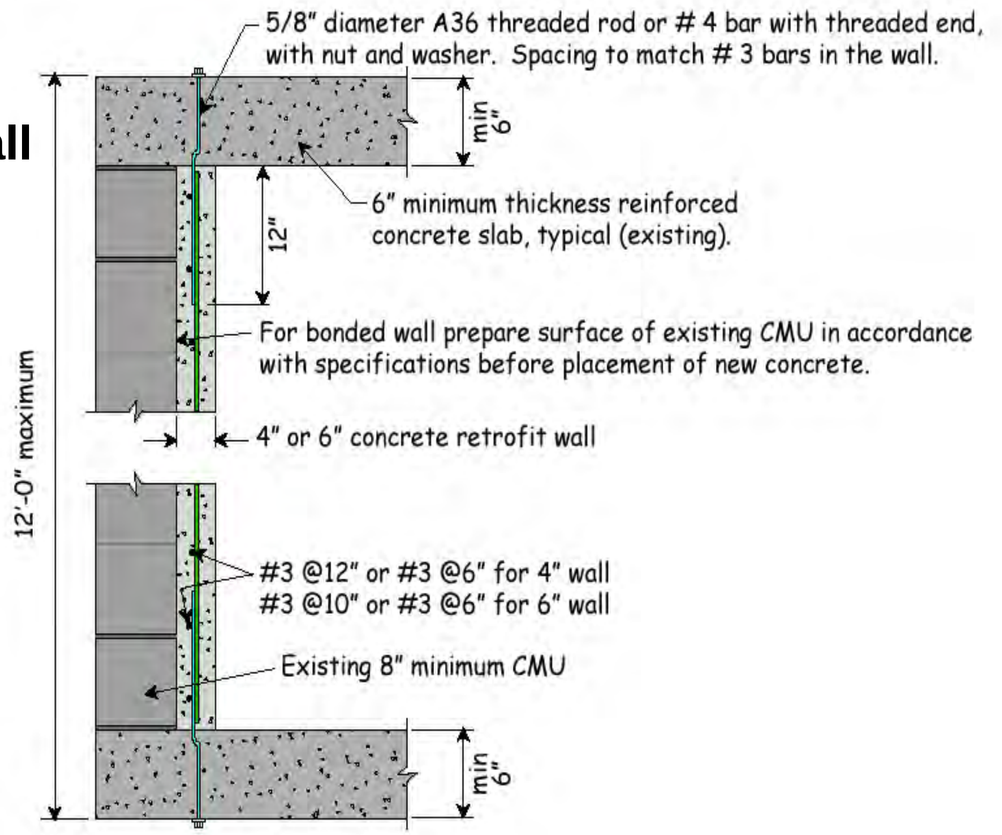
Steel stud wall under construction at Eglin AFB, July 2000

Stiffened Steel Plate Wall Retrofit (Chap. 5)

- Thin steel plate stiffened with structural steel tubes that are anchored into floor diaphragms
- Applicable to load-bearing masonry
- Resulting LOP: Medium
- Installation Difficulty: Medium to High
- Load Bearing: Yes
- Windows: No

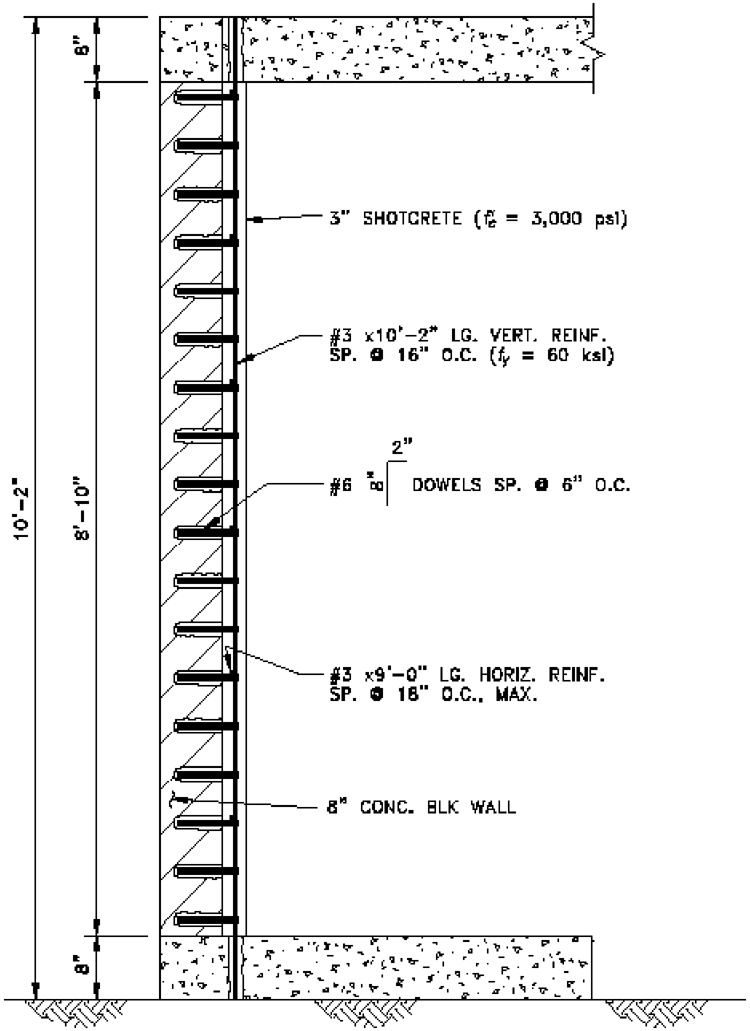
Reinforced Concrete Backing System (Chap. 6)

- Reinforced concrete backing wall placed inside existing wall
- Applicable to reinforced and unreinforced masonry
- Resulting LOP: High
- Installation Difficulty: High
- Load Bearing: Yes
- Windows: Yes



Shotcrete Retrofit for Walls (Chap. 7)

- Reinforced shotcrete doweled into existing masonry
- Applicable to reinforced masonry walls
- Resulting LOP: High
- Installation Difficulty: High
- Load Bearing: Yes
- Windows: Yes



Geotextile Fabric Catcher System (Chap. 8)

- Geotextile curtain anchored behind existing wall
- Applicable to unreinforced masonry
- Resulting LOP: Medium
- Installation Difficulty: Low
- Load Bearing: No
- Windows: No

Polymer Retrofit for Masonry (Chap. 9)

- Spray-on polymer coating applied to interior wall surface
- Applicable to unreinforced masonry
- Resulting LOP: Medium
- Installation Difficulty: Medium
- Load Bearing: No
- Windows: Yes

Geotextile Fabric Catcher System (Chap. 8)

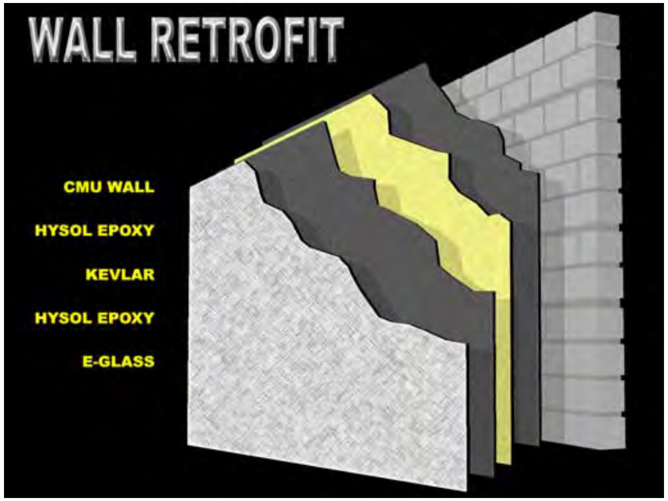
- Geotextile curtain anchored behind existing wall
- Applicable to unreinforced masonry
- Resulting LOP: Medium
- Installation Difficulty: Low
- Load Bearing: No
- Windows: No

Polymer Retrofit for Masonry (Chap. 9)

- Spray-on polymer coating applied to interior wall surface
- Applicable to unreinforced masonry
- Resulting LOP: Medium
- Installation Difficulty: Medium
- Load Bearing: No
- Windows: Yes

Composite Backing System for Masonry (Chap. 10)

- Fiberglass or aramid fabric in epoxy matrix and bonded to wall
- Applicable to unreinforced masonry
- Resulting LOP: Medium
- Installation Difficulty: Low to Medium
- Load Bearing: No
- Windows: No



Metal Stud Wall System (Chap. 11)

- 20 gauge steel sheet supported by steel studs anchored into existing frame
- Applicable to infill stud walls
- Resulting LOP: Medium
- Installation Difficulty: Low to Medium
- Load Bearing: No
- Windows: No

Polymer Retrofit for Wood Construction (Chap. 12)

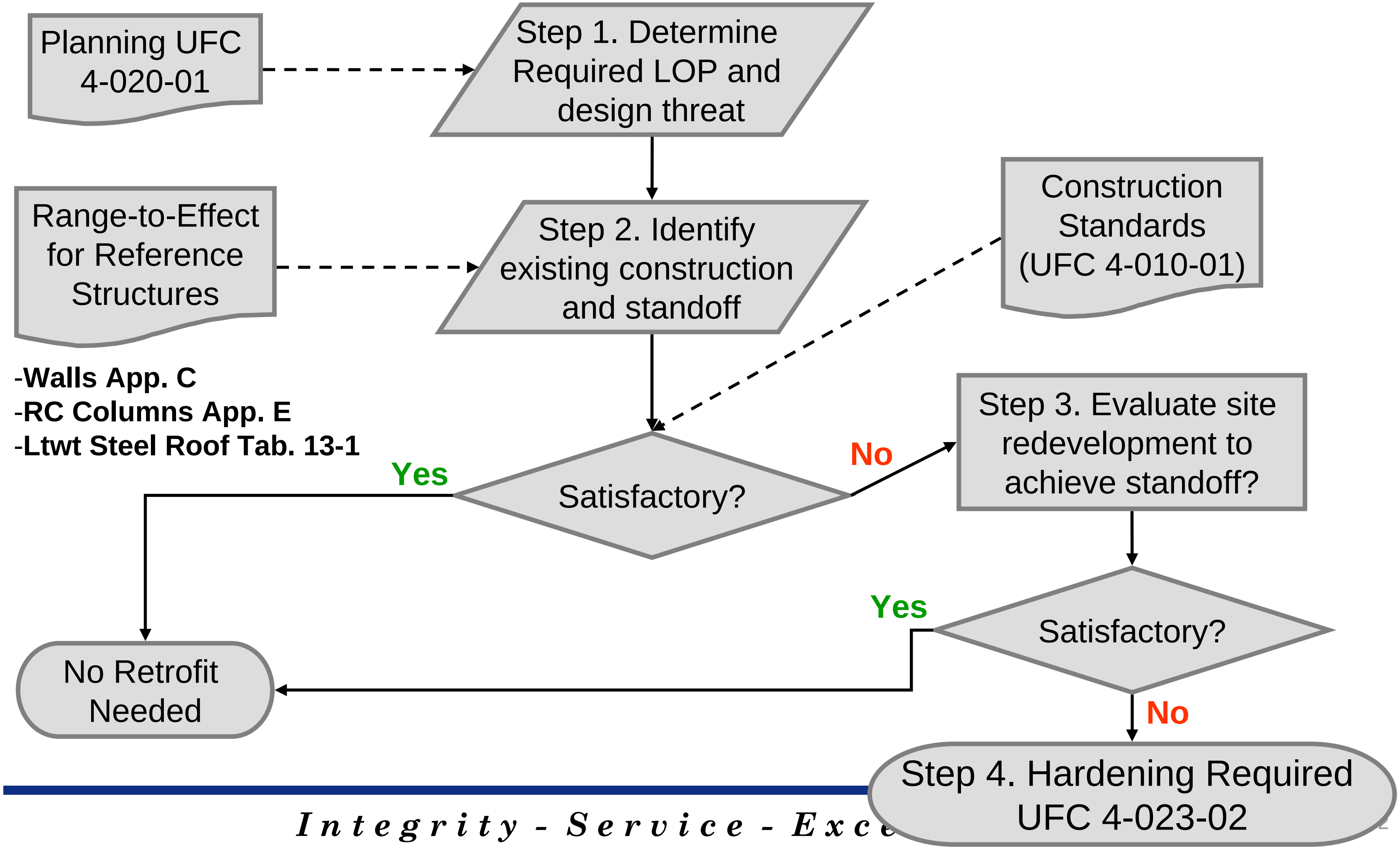
- Spray-on polymer coating applied to interior wall surface
- Applicable to wood stud
- Resulting LOP: Low to High
- Installation Difficulty: Medium
- Load Bearing: No
- Windows: Yes

Ext Int

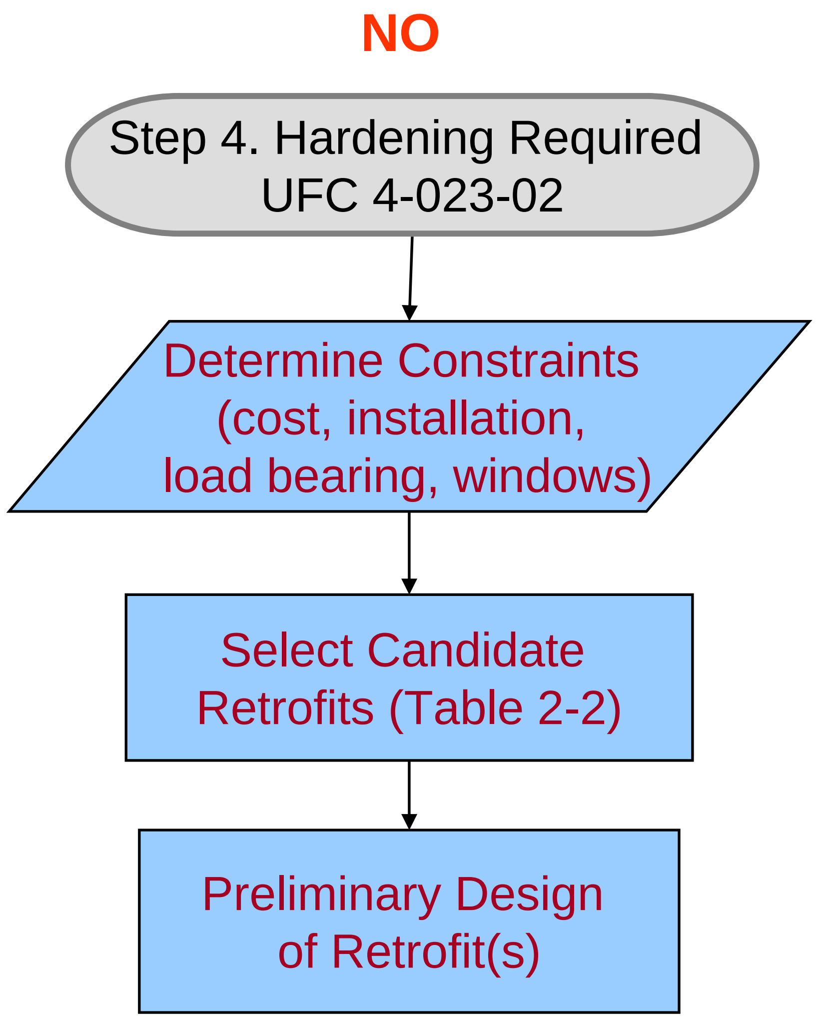
Additional Reinforcing Materials Retrofit for Expeditionary Wood Structures (Chap. 13)

- Additional plywood and dimension lumber attached to structure
- Applicable to expeditionary wood structures (SEA Huts)
- Resulting LOP: Low to High
- Installation Difficulty: Low
- Load Bearing: N/A
- Windows: Yes

Selection of Candidate Wall Retrofit Approaches



Selection of Candidate Wall Retrofit Approaches, continued



Selection of Candidate Wall Retrofit Approaches, continued

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Table 2-2. Wall Retrofit Systems

Retrofit System (Chapter)	Brief Description	Applicable Wall Type(s)	Resulting Injury LOP	Difficulty to Install	Load Bearing Walls?	Walls with Windows?
Thin Steel Plate Catcher System (3)	Thin steel plate anchored into existing frame with optional foam layer	All	Medium	Medium to High	No	No
Steel Stud Wall / Window Retrofit (4)	16 gauge, six-inch deep steel stud wall built inside existing wall	All with Reinf Concrete Frames	Medium	Medium to High	Yes	Yes
Stiffened Steel Plate Wall Retrofit (5)	Thin steel plate stiffened with structural steel tubes anchored into floor diaphragms	Load Bearing Unreinforced and Reinforced Masonry	Medium	Medium to High	Yes	No
Reinforced Concrete Backing (6)	4-inch or 6-inch reinforced concrete backing wall placed against inside wall face	Unreinforced and Reinforced Masonry	High	High	Yes	Yes
Shotcrete (7)	3-inch reinforced shotcrete doweled into existing masonry	Reinforced Masonry	High	High	Yes	Yes
Geotextile (8)	A curtain of geotextile fabric anchored behind existing wall	Unreinforced Masonry	Medium	Low	No	No
Polymer Retrofit for Masonry (9)	Spray-on polymer coating applied to interior wall surface	Unreinforced Masonry	Medium	Medium	No	Yes
High Strength Composite Backing (10)	Field-made composite of fiberglass or aramid fabric in epoxy matrix and bonded to wall	Unreinforced Masonry	Medium	Low to Medium	No	No
Metal Stud Wall System (11)	20 gauge steel sheet supported by steel studs anchored into existing frame	Infill Stud Walls	Medium	Low to Medium	No	No
Polymer Retrofit for Lightweight Structures (12)	Spray-on polymer coating applied to interior wall surface	Wood Stud	Low to High	Medium	No	Yes
Additional Reinforcing Materials (13)	Plywood attached to interior stud walls, floor; dimension lumber to reinforce frame, trusses	Expeditionary Wood Structures (SEA Huts)	Low to High	Low	N/A	Yes

Example Problem: Selection of Candidate Wall Retrofit Approaches

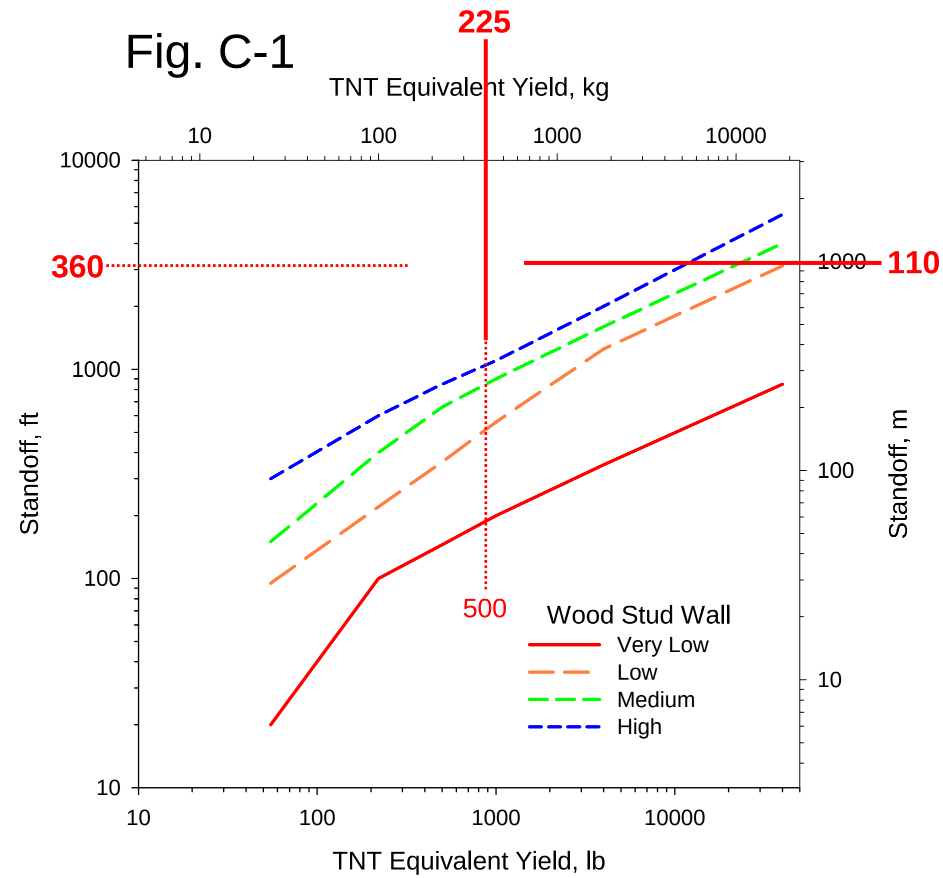
- **Given: 1-story wood barracks,**
  2.4 m (8-ft) walls,
  45 m (150 ft) perimeter standoff
  Required LOP = Low
  Required DBT = 225 kg (500 lb)
- **Find: Evaluate existing structure and select candidate retrofits if needed**

Example Problem, continued

Solution:

- **Step 1 (Given):**
  LOP = Low
  DBT = 225 kg (500 lb)
- **Step 2:**
  From App. C, select
  Wood Stud Wall (Fig. C-1)
  ➔ Required standoff = 110 m

Fig. C-1



45 m (150 ft) < 110 m (360 ft) ➔ **Must Mitigate**

Example Problem, continued

- **Solution:**
  - **Step 3:**
    Assume site layout is fixed and additional standoff is not available
  - **Step 4:**
    Table 2-2 Options:
    Thin Steel Plate Catcher System
    Metal Stud Wall System
    Polymer Retrofit for Wood Construction
    Additional Reinforcing Materials

Example Problem, continued

Inputs from Table 2-2 and Applicable Range-to-Effect Charts

Retrofit System	LOP	Difficult to Install	Load Bearing Walls?	Walls with Windows?	Low LOP Standoff
Thin Steel Plate Catcher System	**Medium**	**Medium to High**	**No**	**No**	**2.4 m (8 ft) (Medium LOP)**
Metal Stud Wall System	**Medium**	**Low to Medium**	**No**	**No**	**27.6 m (90 ft) (Rebuild wall)**
Polymer Retrofit	**Low to High**	**Medium**	**No**	**Yes**	**48.8 m (160 ft)**
Additional Reinforcing Materials	**Low to High**	**Low**	**N/A**	**Yes**	**39.6 m (130 ft)**

Questions?

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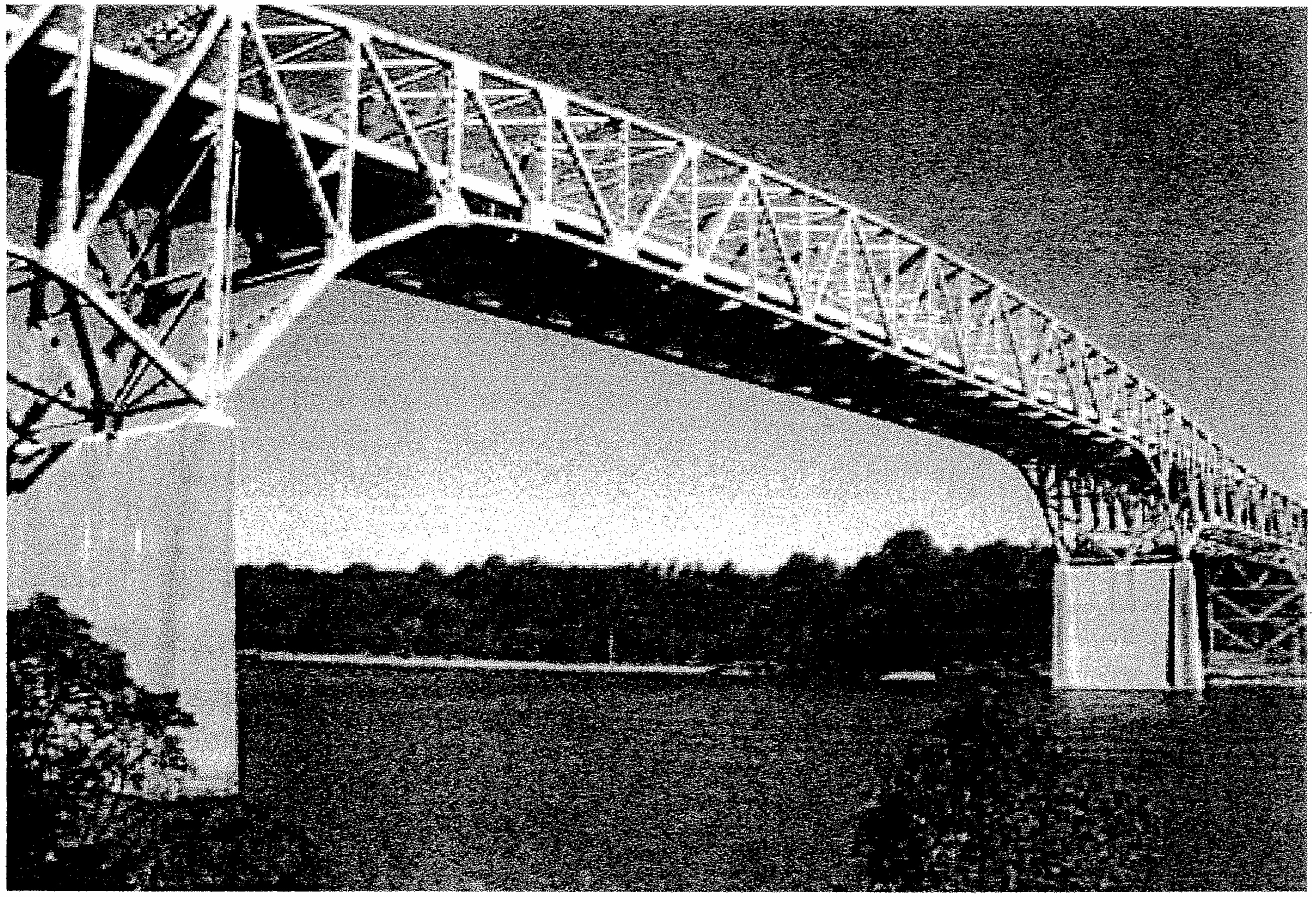
Summit Bridge Fatigue Study

By Jim CHU   Structural Engineer
USACE Philadelphia District



1. Study Purpose

To determine the fatigue life of the main structural members of the Summit Bridge trusses.

2. Structural Description

- Four(4) lanes high level steel bridge
- Total length 2058 ft (See Fig. 1)
- Two(2) 250 ft deck truss span
- One(1) 1200 ft anchor cantilever through truss span
- Four(4) stringer spans total length 358 ft
- AADT volume 27,690 (2003 Del. DOT data)

2.1 Deck Truss

- 250 ft long simply supported truss (Fig.1).
- Ten(10) panels with each panel 25’ long.
- Floor beams are rest on top chord panel points. (Fig. 2)
- All truss members sees only axial load.
- All except two truss members are wide flange shape

2.2 Cantilever Through Truss

- Two(2) 150’ cantilever spans, two(2) 300’ anchor spans, one(1) 300’ suspended span. (Fig.1)
- Forty(40) panels with each panel 30’ long.
- Floor beam is supported at each vertical member (Fig. 4)
- All members sees only axial load.
- All members are riveted built up box section (Fig. 3)

3. Study Procedure

- In accordance with the AASHTO (2003) LRFR manual for highway bridges.
- Infinite life check by Analytical method
- Check again by field measurement method for failed members
- If both methods are failed then finite life calculation is necessary.

3.1 Analytical Method

- Two dimensional truss models.(Fig.5&6)
- Assume pure truss behavior. (only axial load)
- Assume truck load in one lane. (shoulder lane)

3.1.1 Model Geometry and Boundary Conditions

- All member info. obtained from special load program ‘SMTBRM’ user’s manual
- Deck Truss (Fig. 5):

a. Simply supported

b. Calculation only need for half of truss

c. Load concentrate apply at top panel pt.

3.1.1 Model Geometry and Boundary Condition (Cont'd)

- Through Truss (Fig. 6):
  a. Half truss modeled and analyzed
  b. truss supported by pin at node L10 and roller at node L0
  c. suspended span supported by pin at node L15
  d. load applied at each vertical member (Fig.4)

3.1.2 Loading

- Dead loads-
  1. Wt. of truss member, wt. of floor system steel, wt. of slab and wearing surface, wt. of parapet.
  2. Applied concentrately at each top panel pt.
  3. Cross-sections of deck& through truss. see Fig. 2&4

3.1.2 Loading (Cont'd)

- Live loads- Based on AASHTO LRFD 2004 spec.

  1. AASHTO Paragraph 3.6.1.4- Fatigue truck (see Fig.7)

  2. AASHTO Paragraph 3.6.1.4.2-The single lane ADTT is for shoulder lane.

3.1.2 Loading (Cont'd)

- Live load (Cont'd)

  3. AASHTO Paragraph 3.6.1.4.3- distribution factor DF is equal to the support reaction due to a unit load located at truck location. (see Fig. 8)
  4. AASHTO Paragraph 3.6.2.1- add 15% to impact load.

3.1.3 Member forces and stress range

- Dead load forces and stresses- See Table 1
- Live load forces-
  1. Assume truck load as single point load.
  2. Add impact and multiply by proper DF.
  3. Find Max. and Min. Influence line coef.
  4. Use net cross section area
  5. See Table 2,3.1,3.2,3.3

3.1.3 Member Forces and Stress Range (Cont'd)

- Live load stress range Sr- Sum of Max. tension and compression stress
- Live load stress range tension component St
- Dead load compression stress Sc
- See Table 4,5.1,5.2,5.3

3.1.4 Infinite-Life Check

- Fatigue Category-
  1. AASHTO LRFR (2003) section 7.2.1 defines rivet connection as Category C
  2. Bower(1994) states rivet with tack weld reduced to Category E
- Infinite-life Check- AASHTO LRFR 7.2.4
  a. $2Rs(0.75Sr) < F_{TH}$ or
  b. $2Rs(0.75St) < Sc$

3.1.4 Infinite-Life Check (Cont'd)

where,

R_s: stress uncertainty factor, AASHTO LRFR Table 7.1, 1 for simplified analysis

S_r: unfactored life load stress range

F_{TH}: fatigue threshold, AASHTO LRFD 2004 Table 6.6.1.2.5-3, 4.5 for Category E

S_t : unfactored life load tension portion of S_r

S_c : unfactored dead load compression stress

3.1.4 Infinite-Life Check (Cont'd)

- The factor of 2 is for max. possible stress for entire life of bridge, LRFR sect. 7.2.2.2
- Results shown in Table 4,5.1,5.2,5.3
- Fracture Critical Members (FCM) are members with dead load tensile stress.
- Four(4) members failed infinite life check
- Will check again by field measured effective stress range

3.2 Field Measurement Method

- Analytical method is conservative due to:
  1. assume pure truss member (bending effect neglected)
  2. 2-D model (ignored floor beam and cross brace effect)
  3. Fatigue truck is assumed load, and in shoulder lane only.

3.2 Field Measurement Method (Cont'd)

- Field measured effective stress expect lower
- Four(4) members with finite life and six(6) members with high stress to be tested by Structural Testing Inc. (STI)
- Results shown in Table 6
- Consider infinite life if

  $2f_{eff}$ or $2 R_s f < F_{TH}$

  where,

3.2 Field Measurement Method (Cont'd)

Rs: stress uncertainty factor AASHTO LRFR Table 7.1, 0.85 for measured stress

f : measured effective stress range

- All members pass infinite-life check

4. Comparison of Analytical and Field Measured Stress Range

- AASHTO LRFR section 7.2.2 The effective stress range shall be estimated as

  $f_{eff} = Rs\ f$

  where,

  Rs: stress uncertainty factor, AASHTO LRFR Table 7.1, 0.85 for field measured method,1.0 for simplified analysis method

4. Comparison of Analytical and Field Measured Results (Cont'd)

f : measured effective stress range; or

0.75 of calculated stress range (Sr)

- Sr recalculated to remove conservatism (truck load three point load instead of one point load)
- Result listed in Table 6

5. Conclusion and Recommendation

- Fatigue problem does not exist for the Summit Bridge trusses. All truss members has infinite fatigue life.
- Calculated effective stress range is about 10% to 90% higher than measured effective stress range for Summit Bridge truss members.
- No need to remove all un-cracked tack welds. However, cracked tack weld shall be removed as identified.

Table 1

Table 1. Dead Load Stress					
Deck Truss		Through Truss			
Member	Stress (ksi)	Member	Stress (ksi)	Member	Stress
L0L2	13.4	L0L2	0.7	U1U3	1.3
L2L4	18.1	L2L4	-5.6	U3U5	12.6
L4L6	17.9	L4L6	-14.1	U5U7	16
U1U3	-14.9	L6L7	-15.7	U7U8	17
U3U5	-15.4	L7L8	-16.7	U8U9	17.7
L0U0	-3.4	L8L9	-17.2	U9U10	18
L2U2	-6.4	L9L10	-17.2	U10U11	18.6
L4U4	-6.6	L10L11	-17.3	U11U12	18.6
L0U1	-14	L11L12	-17.5	U12U13	18.7
U1L2	17.6	L12L13	-17.5	U13U15	17.6
L2U3	-9.8	L13L14	-17.6	U16U18	-17
U3L4	12.2	L15L17	15.4	U18U20	-17.1
L4U5	-4	L17L19	18.1		
		L19L20	18.4		
		L0U0	-3.18	L0U1	-1.8
		L1U1	6.4	U1L2	-4.9
		L2U2	-4.4	L2U3	13.9
		L3U3	6.4	U3L4	-13.7
		L4U4	-4.7	L4U5	17.4
		L5U5	6.6	U5L6	-14.8
		L6U6	-5.4	L6U7	18.3
		L7U7	-12.9	L7U8	18.5
		L8U8	-13.8	L8U9	17.6
		L9U9	-12.4	L9U10	-9.2
		L10U10	13.9	U10L11	-13.5
		L11U11	-10.7	U11L12	12.3
		L12U12	-16.9	U12L13	18.5
		L13U13	-16.6	U13L14	18.5
		L15U15	19.5	L14U15	-14.8
		L16U16	4.4	L15U16	-15.3
		L18U18	6.6	U16L17	18.3
		L20U20	6.8	L17U18	-13.6
				U18L19	12.2
				L19U20	-3.1

Table 2

Table 2. Member Forces: Deck Truss			
Member	Max. Axial LL+I (kips)	Min. Axial F LL+I (kips)	Net Area (in^2)
L0L2	67.3	0	39.91
L2L4	157	0	69.7
L4L6	187	0	84.4
U1U3	0	-120	64.4
U3U5	0	-180	94.1
L0U0	0	-100	21.5
L2U2	0	-100	21.5
L4U4	0	-100	21.5
L0U1	0	-113	64.16
U1L2	100	-13	39.91
L2U3	25	-88	46.04
U3L4	75	-38	25.49
L4U5	50	-63	25.49

Table 3.1

Table 3.1 Member Forces: Through Truss			
Member	Max. Axial LL+I (kips)	Min. Axial F LL+I (kips)	Net Area (in ^{2})
L0L2	51	-28	51.88
L2L4	113	-65	51.88
L4L6	122	-122	73.62
L6L7	89	-148	130.12
L7L8	61	-153	152.72
L8L9	31	-152	163.36
L9L10	0	-149	208.51
L10L11	0	-196	273.01
L11L12	0	-182	231.49
L12L13	0	-161	187.51
L13L14	0	-109	115.51
L15L17	43	0	41.71
L17L19	94	0	78.48
L19L20	109	0	89.78
U1U3	55	-89	51.88
U3U5	103	-123	53.01
U5U7	137	-110	102.11
U7U8	150	-90	130.36
U8U9	155	-62	155.81
U9U10	153	-31	176.38
U10U11	158	0	188.55
U11U12	160	0	175.72
U12U13	110	0	109.55
U13U15	52	0	50.18
U16U18	0	-65	65.24
U18U20	0	-106	92.24

Table 3.2

Table 3.2 Member Forces: Through Truss			
Member	Max. Axial Force LL+I (kips)	Min. Axial Force LL+I (kips)	Net Area (in^2)
L0U0	0	-73	31.54
L1U1	73	0	27.21
L2U2	0	-73	38.82
L3U3	73	0	27.21
L4U4	0	-73	36.5
L5U5	73	0	27.31
L6U6	0.1	-73	32.79
L7U7	6.6	-63	70.17
L8U8	1.7	-69	68.22
L9U9	0.3	-73	75.88
L10U10	130	-73	95.39
L11U11	0	-73	47.75
L12U12	0	-73	100.94
L13U13	0	-83	104.19
L15U15	73	0	61.73
L16U16	73	0	40.16
L18U18	73	0	27.59
L20U20	73	0	27.68

Table 3.3

Table 3.3 Member Forces: Through Truss			
Member	Max. Axial Force LL+I (kips)	Min. Axial Force LL+I (kips)	Net Area (in^2)
L0U1	47	-84	29.82
U1L2	70	-43	29.82
L2U3	43	-61	29.82
U3L4	43	-36	38.13
L4U5	46	-35	47.46
U5L6	20	-55	54.2
L6U7	65	-15	62.38
L7U8	75	-4	60.56
L8U9	79	-5	56.49
L9U10	76	-75	55.58
U10L11	49	-70	72.8
U11L12	63	-4	30.57
U12L13	84	0	103.62
U13L14	95	0	103.62
L14U15	0	-93	107
L15U16	0	-78	77.13
U16L17	66	-11	47.06
L17U18	21	-57	38.99
U18L19	49	-28	28.66
L19U20	37	-40	23.59

Table 4

Table 4 Member Stresses and Fatigue Life: DECK TRUSS						
Member	S_r (ksi)	S_t (ksi)	S_c (ksi)	Y_f (yrs)		
L0L2	1.69	1.69	0	infinite	2Rs(0.75Sr)<4.5	(FCM)
*L2L4	2.25	2.25	0	infinite	2Rs(0.75Sr)<4.5	(FCM)
*L4L6	2.21	2.21	0	infinite	2Rs(0.75Sr)<4.5	(FCM)
U1U3	1.86	0	-14.9	infinite	$S_c>2R_s(0.75S_t)$	
U3U5	1.91	0	-15.4	infinite	$S_c>2R_s(0.75S_t)$	
L0U0	4.65	0	-3.4	infinite	$S_c>2R_s(0.75S_t)$	
L2U2	4.65	0	-6.4	infinite	$S_c>2R_s(0.75S_t)$	
L4U4	4.65	0	-6.6	infinite	$S_c>2R_s(0.75S_t)$	
L0U1	1.76	0	-14	infinite	$S_c>2R_s(0.75S_t)$	
*U1L2	2.83	2.5	0	infinite	2Rs(0.75Sr)<4.5	(FCM)
L2U3	2.45	0.54	-9.8	infinite	$S_c>2R_s(0.75S_t)$	
*U3L4	4.43	2.94	0	finite		(FCM)
L4U5	4.43	1.96	-4	infinite	$S_c>2R_s(0.75S_t)$	

*Members(FCM) with highest stress range were selected for field stress measurement

Table 5.1

Table 5.1 Member Stress and Fatigue Life: THROUGH TRUSS						
Member	S_r (ksi)	S_t (ksi)	S_c (ksi)	Y_f (yrs)		
L0L2	1.55	0.99	0	infinite	$2R_s(0.75S_r)<4.5$	(FCM)
L2L4	3.45	2.2	-5.6	infinite	$S_c>2R_s(0.75S_t)$	
L4L6	3.33	1.67	-14.1	infinite	$S_c>2R_s(0.75S_t)$	
L6L7	1.84	0.69	-15.7	infinite	$S_c>2R_s(0.75S_t)$	
L7L8	1.43	0.4	-16.7	infinite	$S_c>2R_s(0.75S_t)$	
L8L9	1.33	0.2	-17.2	infinite	$S_c>2R_s(0.75S_t)$	
L9L10	0.72	0	-17.2	infinite	$S_c>2R_s(0.75S_t)$	
L10L11	0.72	0	-17.3	infinite	$S_c>2R_s(0.75S_t)$	
L11L12	0.8	0	-17.5	infinite	$S_c>2R_s(0.75S_t)$	
L12L13	0.87	0	-17.5	infinite	$S_c>2R_s(0.75S_t)$	
L13L14	0.95	0	-17.6	infinite	$S_c>2R_s(0.75S_t)$	
L15L17	1.03	1.03	0	infinite	$2R_s(0.75S_r)<4.5$	(FCM)
L17L19	1.21	1.21	0	infinite	$2R_s(0.75S_r)<4.5$	(FCM)
L19L20	1.23	1.23	0	infinite	$2R_s(0.75S_r)<4.5$	(FCM)
*U1U3	2.79	1.07	0	infinite	$2R_s(0.75S_r)<4.5$	(FCM)
*U3U5	4.31	1.95	0	finite	$2R_s(0.75S_r)<4.5$	(FCM)
*U5U7	2.44	1.35	0	infinite	$2R_s(0.75S_r)<4.5$	(FCM)
U7U8	1.85	1.16	0	infinite	$2R_s(0.75S_r)<4.5$	(FCM)
U8U9	1.39	1	0	infinite	$2R_s(0.75S_r)<4.5$	(FCM)
U9U10	1.04	0.88	0	infinite	$2R_s(0.75S_r)<4.5$	(FCM)
U10U11	0.85	0.85	0	infinite	$2R_s(0.75S_r)<4.5$	(FCM)
U11U12	0.92	0.92	0	infinite	$2R_s(0.75S_r)<4.5$	(FCM)
U12U13	1.01	1.01	0	infinite	$2R_s(0.75S_r)<4.5$	(FCM)
U13U15	1.04	1.04	0	infinite	$2R_s(0.75S_r)<4.5$	(FCM)
U16U18	1	0	-17	infinite	$S_c>2R_s(0.75S_t)$	
U18U20	1.17	0	-17.1	infinite	$S_c>2R_s(0.75S_t)$	

* FCM with highest stress range were selected for field stress measurement

Table 5.2

Table 5.2 Member Stress and Fatigue Life: THROUGH TRUSS						
Member	S_r (ksi)	S_t (ksi)	S_c (ksi)	Y_f (yrs)		
L0U0	2.33	0	-3.18	infinite	$S_c>2R_s(0.75S_t)$	
L1U1	2.71	2.71	0	infinite	$2R_s(0.75S_r)<4.5$	(FCM)
L2U2	1.89	0	-4.4	infinite	$S_c>2R_s(0.75S_t)$	
L3U3	2.71	2.71	0	infinite	$2R_s(0.75S_r)<4.5$	(FCM)
L4U4	2.03	0	-4.7	infinite	$S_c>2R_s(0.75S_t)$	
L5U5	2.7	2.7	0	infinite	$2R_s(0.75S_r)<4.5$	(FCM)
L6U6	2.24	0	-5.4	infinite	$S_c>2R_s(0.75S_t)$	
L7U7	1	0.1	-12.9	infinite	$S_c>2R_s(0.75S_t)$	
L8U8	1.05	0.03	-13.8	infinite	$S_c>2R_s(0.75S_t)$	
L9U9	0.97	0.004	-12.4	infinite	$S_c>2R_s(0.75S_t)$	
L10U10	2.15	1.37	0	infinite	$2R_s(0.75S_r)<4.5$	(FCM)
L11U11	1.55	0	-10.7	infinite	$S_c>2R_s(0.75S_t)$	
L12U12	0.72	0	-16.9	infinite	$S_c>2R_s(0.75S_t)$	
L13U13	0.81	0	-16.6	infinite	$S_c>2R_s(0.75S_t)$	
L15U15	1.2	1.2	0	infinite	$2R_s(0.75S_r)<4.5$	(FCM)
L16U16	1.84	1.84	0	infinite	$2R_s(0.75S_r)<4.5$	(FCM)
L18U18	2.67	2.67	0	infinite	$2R_s(0.75S_r)<4.5$	(FCM)
L20U20	2.67	2.67	0	infinite	$2R_s(0.75S_r)<4.5$	(FCM)

Table 5.3

Table 5.3 Member Stress and Fatigue Life: THROUGH TRUSS						
Member	S_r (ksi)	S_t (ksi)	S_c (ksi)	Y_f (yrs)		
*L0U1	4.41	1.57	-1.8	finite		
*U1L2	3.81	2.36	-4.9	infinite	S_c>2R_s(0.75S_t)	
*L2U3	3.52	1.47	0	finite		(FCM)
U3L4	2.09	1.15	-13.7	infinite	S_c>2R_s(0.75S_t)	
L4U5	1.73	0.99	0	infinite	2R_s(0.75S_r)<4.5	(FCM)
U5L6	1.41	0.37	-14.8	infinite	S_c>2R_s(0.75S_t)	
L6U7	1.29	1.05	0	infinite	2R_s(0.75S_r)<4.5	(FCM)
L7U8	1.32	1.25	0	infinite	2R_s(0.75S_r)<4.5	(FCM)
L8U9	1.49	1.4	0	infinite	2R_s(0.75S_r)<4.5	(FCM)
L9U10	2.73	1.39	-9.2	infinite	S_c>2R_s(0.75S_t)	
U10L11	1.64	0.68	-13.5	infinite	S_c>2R_s(0.75S_t)	
U11L12	2.23	2.09	0	infinite	2R_s(0.75S_r)<4.5	(FCM)
U12L13	0.83	0.83	0	infinite	2R_s(0.75S_r)<4.5	(FCM)
U13L14	0.93	0.93	0	infinite	2R_s(0.75S_r)<4.5	(FCM)
L14U15	0.88	0	-14.8	infinite	S_c>2R_s(0.75S_t)	
L15U16	1.03	0	-15.3	infinite	S_c>2R_s(0.75S_t)	
U16L17	1.63	1.41	0	infinite	2R_s(0.75S_r)<4.5	(FCM)
L17U18	2	0.55	-13.6	infinite	S_c>2R_s(0.75S_t)	
U18L19	2.67	1.72	0	infinite	2R_s(0.75S_r)<4.5	(FCM)
L19U20	3.29	1.57	-3.1	infinite	S_c>2R_s(0.75S_t)	

*Members with highest stress range were selected for field stress measurement

Table 6

Table 6. Comparison of calculated and field measured effective stress			
Deck Truss			
Member	f_{eff} (ksi)-Calculated	f_{eff}(ksi)-Field measured	Ratio
L4L5	1.46	1.24	1.17
L3L4	1.57	0.81	1.93
U3L4	2.6	2.02	1.28
U1L2	1.78	1.58	1.13
Through Truss			
L0U1	2.99	1.377	2.17
U1L2	2.51	1.5	1.67
U3U4	2.96	1.53	1.93
U5U6	1.69	0.94	1.8
U2U3	1.92	1.34	1.43
L2U3	2.34	1.71	1.37

Fig. 1

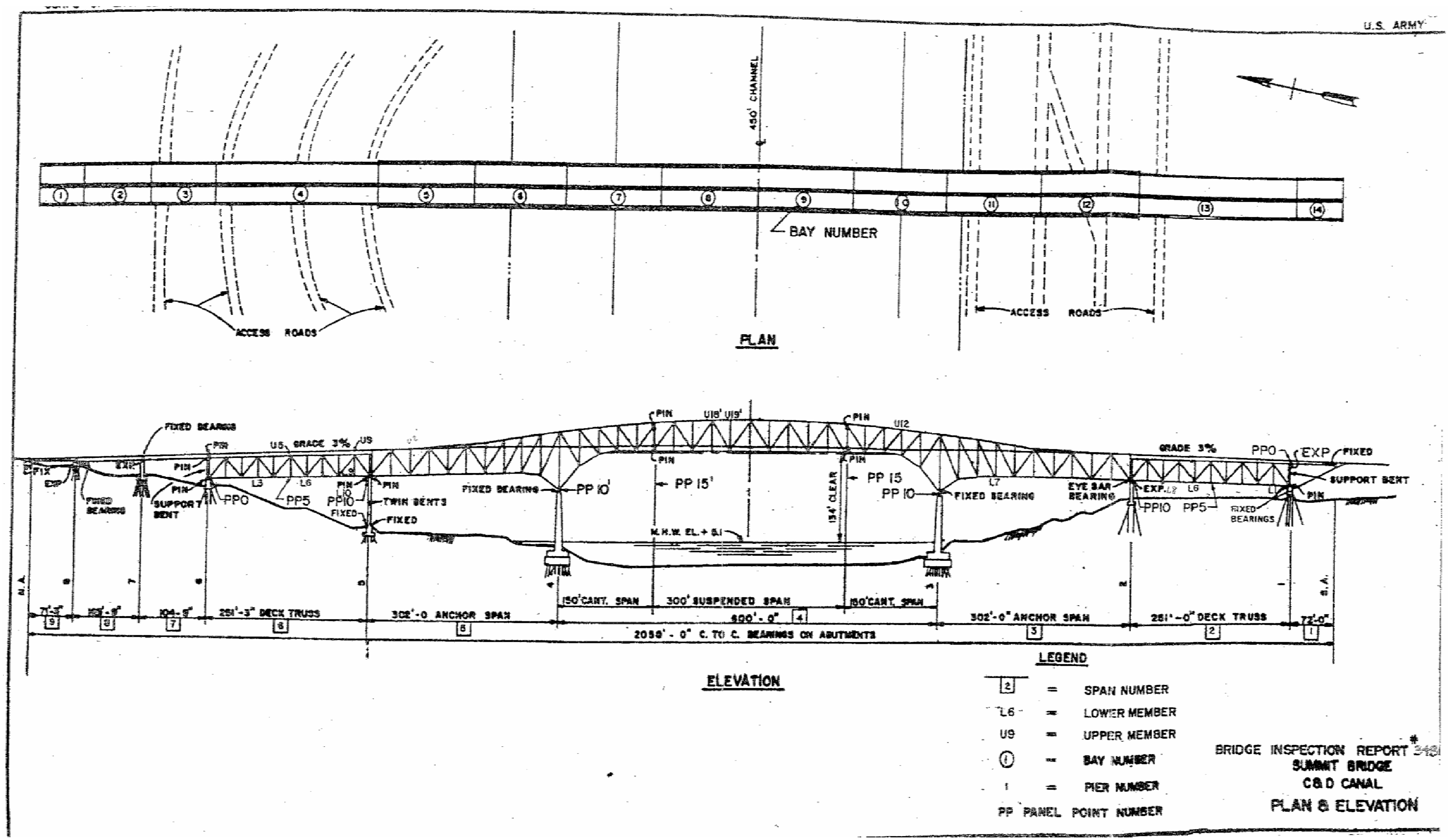
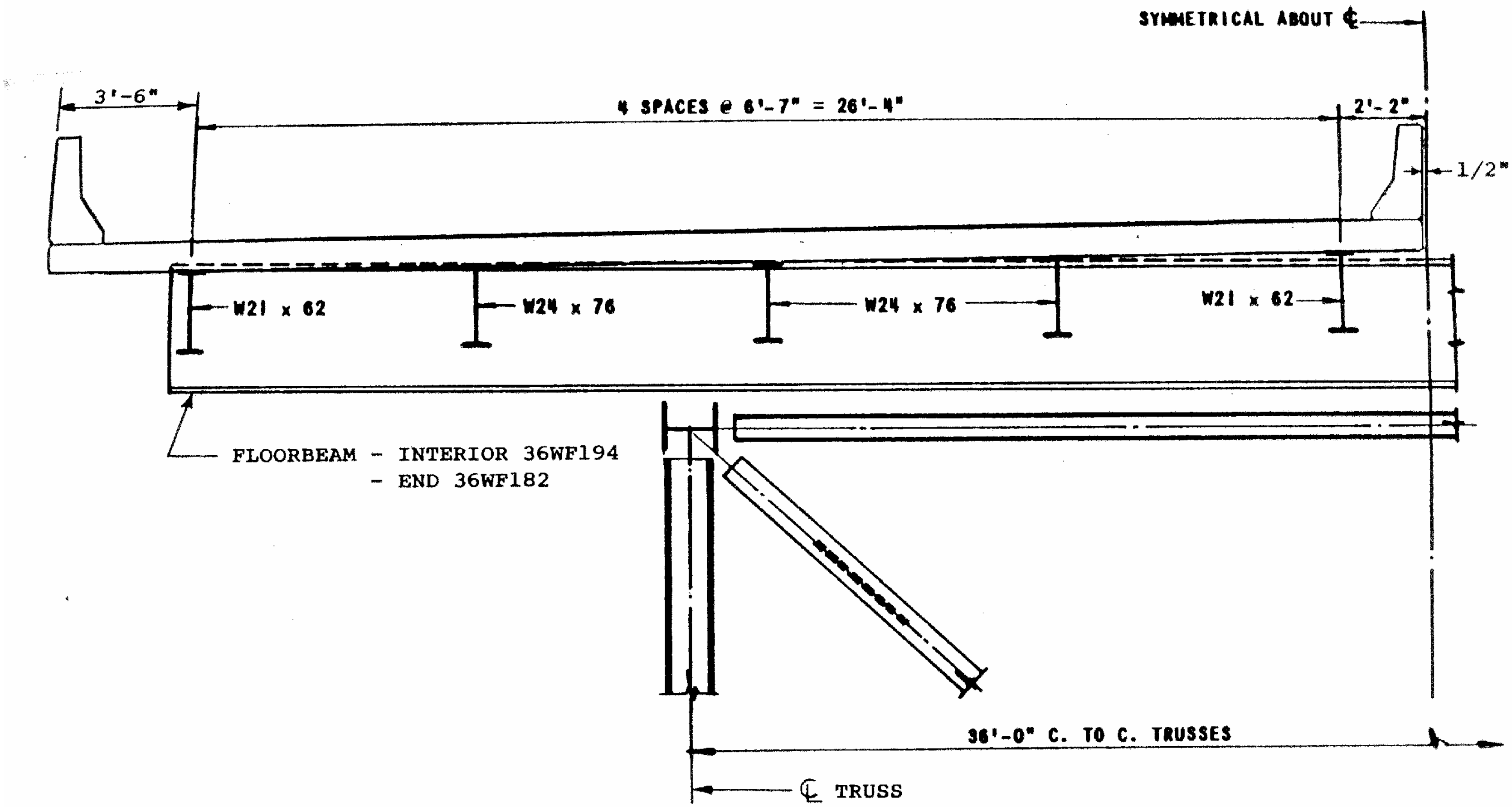
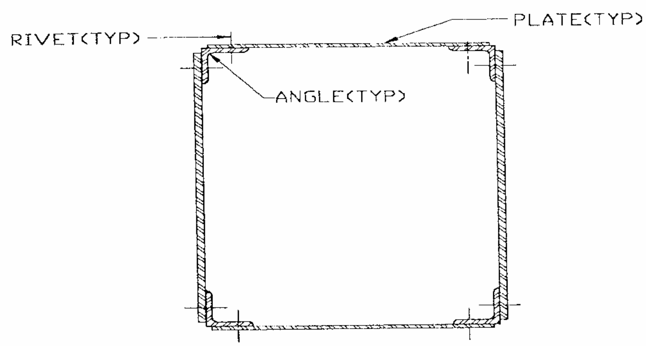

U.S. ARMY
450' CHANNEL
BAY NUMBER
ACCESS ROADS
PLAN
FIXED BEARINGS
GRADE 3%
PP 10'
PP 15'
PP 15
PP 10
FIXED BEARING
M.H.W. EL. + 8.1
134' CLEAR
EYE BAR BEARING
SUPPORT BENT
TWIN BENTS
150' CANT. SPAN
300' SUSPENDED SPAN
251'-3" DECK TRUSS
302'-0 ANCHOR SPAN
600'-0"
302'-0" ANCHOR SPAN
251'-0" DECK TRUSS
2059'-0" C. TO C. BEARINGS ON ABUTMENTS
ELEVATION
LEGEND
= SPAN NUMBER
= LOWER MEMBER
= UPPER MEMBER
= BAY NUMBER
= PIER NUMBER
PP PANEL POINT NUMBER
BRIDGE INSPECTION REPORT
SUMMIT BRIDGE
C&D CANAL
PLAN & ELEVATION

Fig. 2

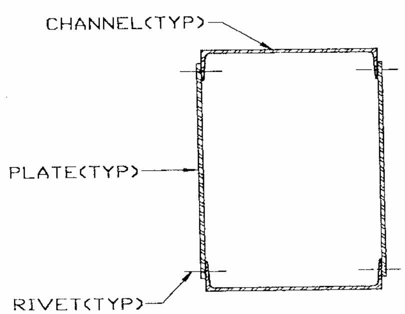


250 FT. DECK TRUSS
TYPICAL HALF CROSS SECTION

Fig. 3



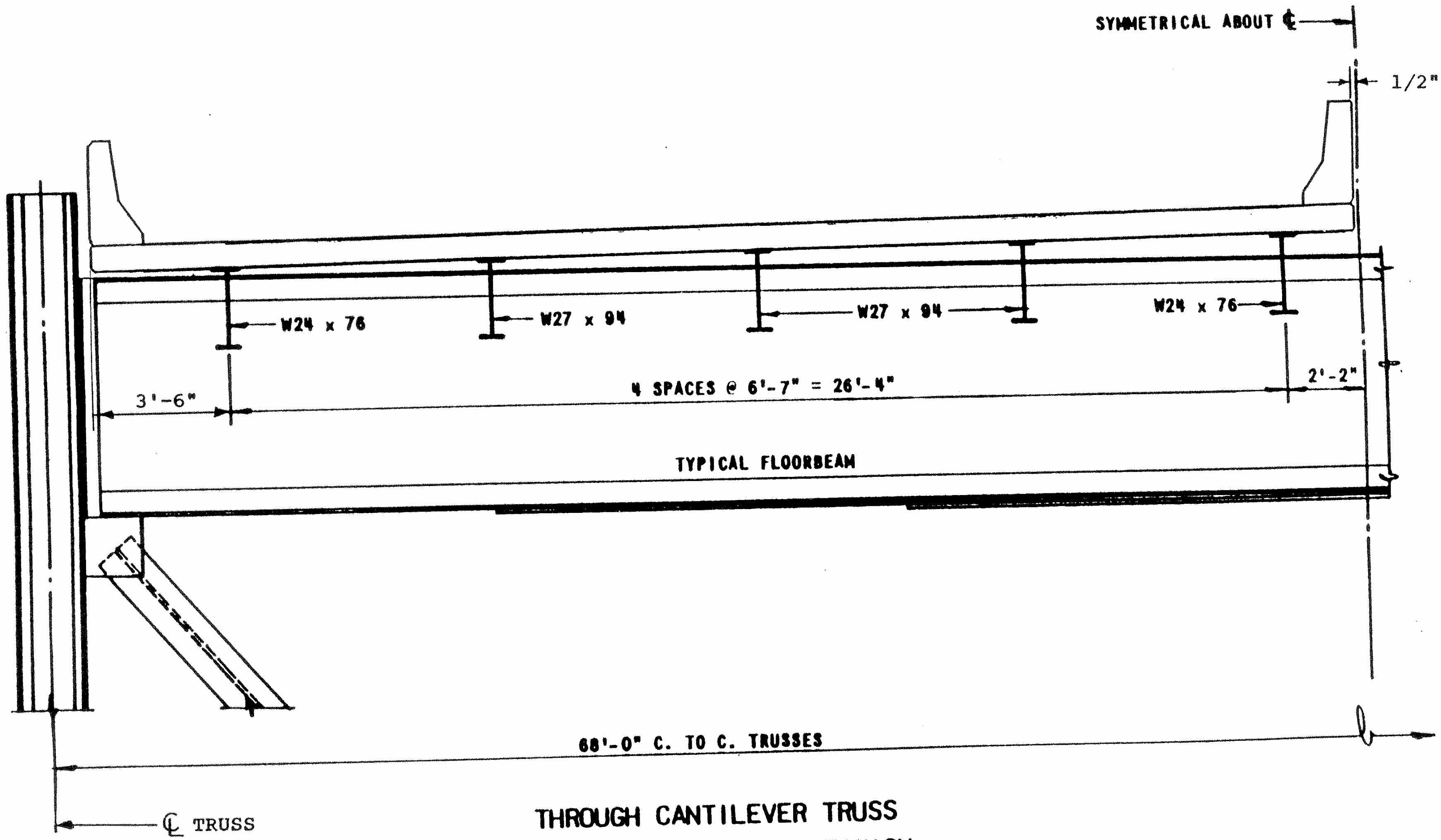
a. BOX SECTION: PLATES AND ANGLES



b. BOX SECTION: CHANNELS AND PLATES

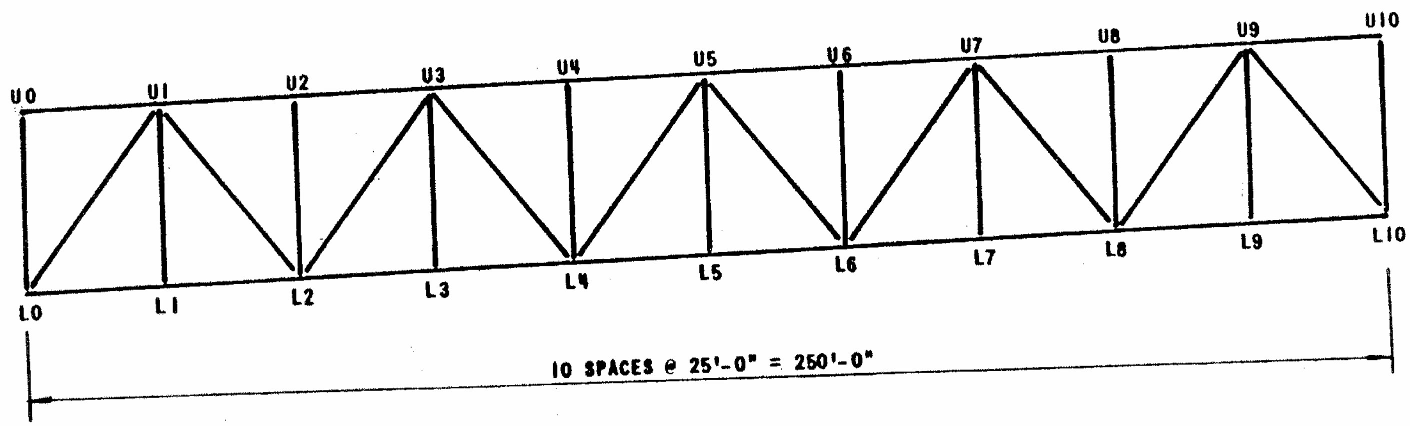
FIGURE 3. TYPICAL MEMBER CROSS SECTIONS

Fig. 4



THROUGH CANTILEVER TRUSS
TYPICAL HALF CROSS SECTION

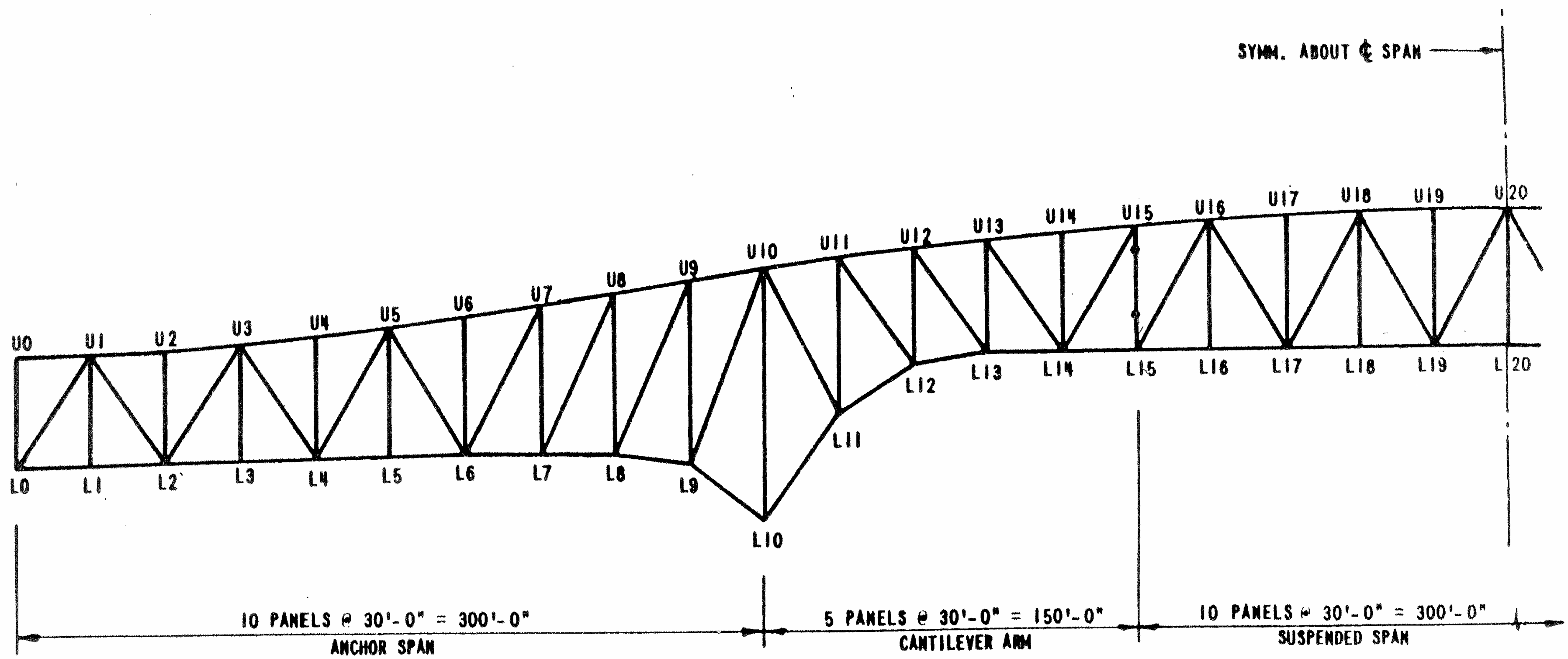
Fig. 5



250 FT. DECK TRUSS

FRAMING PLAN AND ELEVATION

Fig. 6



THROUGH CANTILEVER TRUSS

HALF ELEVATION AND FRAMING PLAN

Fig. 7

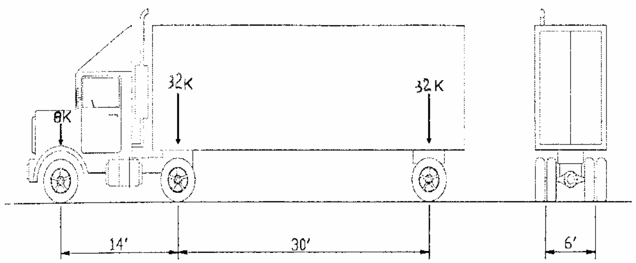


FIGURE 7. AASHTO(2004) FATIGUE TRUCK

Fig. 8

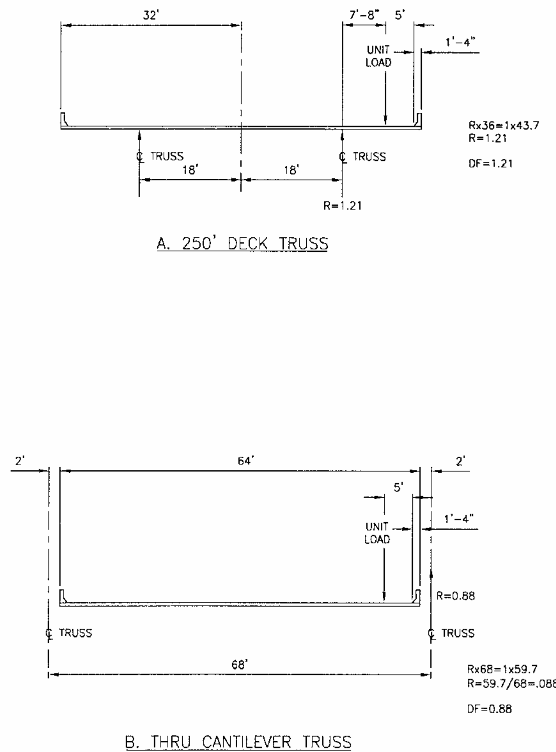


FIG. 8 CALCULATION OF DISTRIBUTION FACTOR

Barge Impact Analysis for Rigid Lock Walls ETL 1110-2-563

John D. Clarkson, Huntington District

Robert C. Patev, New England District

Typical US Locks and Dam

Barge Impact due to loss of control

Topics

- Background on ETL
- Rigid Wall Guidance ETL
- Continuing efforts

Vessel Impact Task Group Members

- Headquarters
  - Don Dressler
  - Anjana Chudgar
- Districts
  - John Clarkson, Huntington
  - Bob Patev, New England
  - Joe Kubinski, Detroit
  - Andy Harkness, Pittsburgh
  - Terry Sullivan, Louisville
  - Mark Gonski, New Orleans
- ERDC
  - Bob Ebeling, ITL
  - Bruce Barker, ISD

Why write a new ETL?

- ETL 1110-2-338 rescinded in 1999
  - Method was felt too conservative for design
  - Uses permanent deformation of barge
  - Issued interim guidance letter
  - Yielded unexpected results

Why write a new ETL?

Innovations for Navigation Projects (INP) R&D Barge Impact Efforts

- Full-scale experiments
  - 4-barge (Prototype – Pittsburgh - ERDC/ITL Technical Report ITL-03-2)
  - 15-barge (Full-scale – RC Byrd - ERDC/ITL Technical Report ITL-03-8)
  - Crushing (New Orleans)

Full-Scale Experiments

- Primary goals:
  - Measure baseline response of barge corner
  - Measure actual impact forces normal to wall using load measuring devices
  - Investigate the use of energy absorbing fenders
  - Quantify a MDOF barge system during impact
  - Use results to validate/invalidate existing ETL model

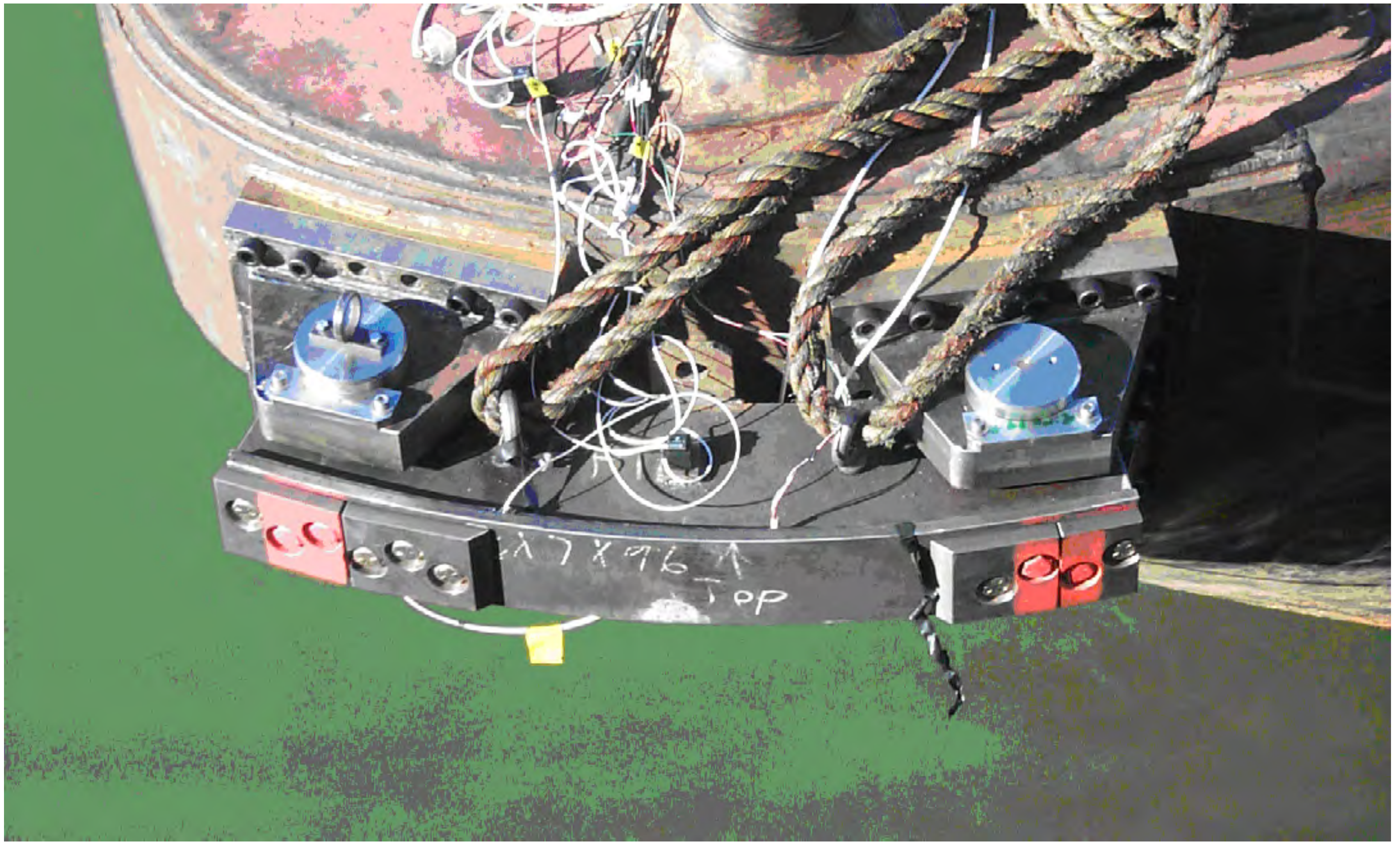
Full-Scale Experiments

Full-Scale Experiments

- Used a 15 barge commercial tow drafting at 9 feet
  - Mass of tow approximately 32,000 tons – 29,000 metric tons
- Impacts on
  - Upper guide wall
  - "Prototype" energy absorbing fendering system
- Successfully conducted 44 full-scale impact experiments
  - 12 baseline on concrete
  - 9 baseline on fendering system
  - 18 load measurement on concrete
  - 5 load measurement on fendering systems
- Impacts at:
  - Velocities from 0.5 to 4.1 feet per second
  - Angles from 5 to 25 degrees

Full-Scale Experiments

- Clevis Pin Load Beam

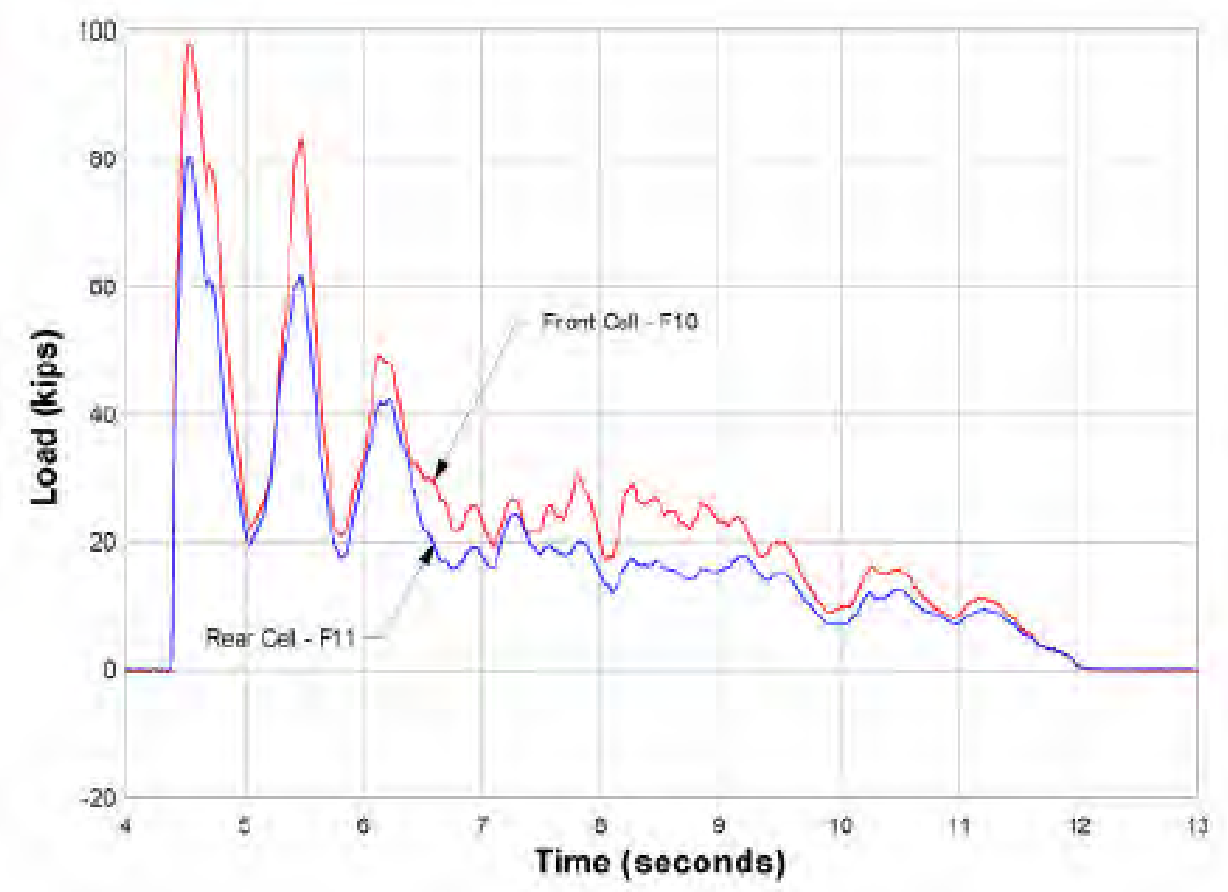


Full-Scale Crushing Experiments

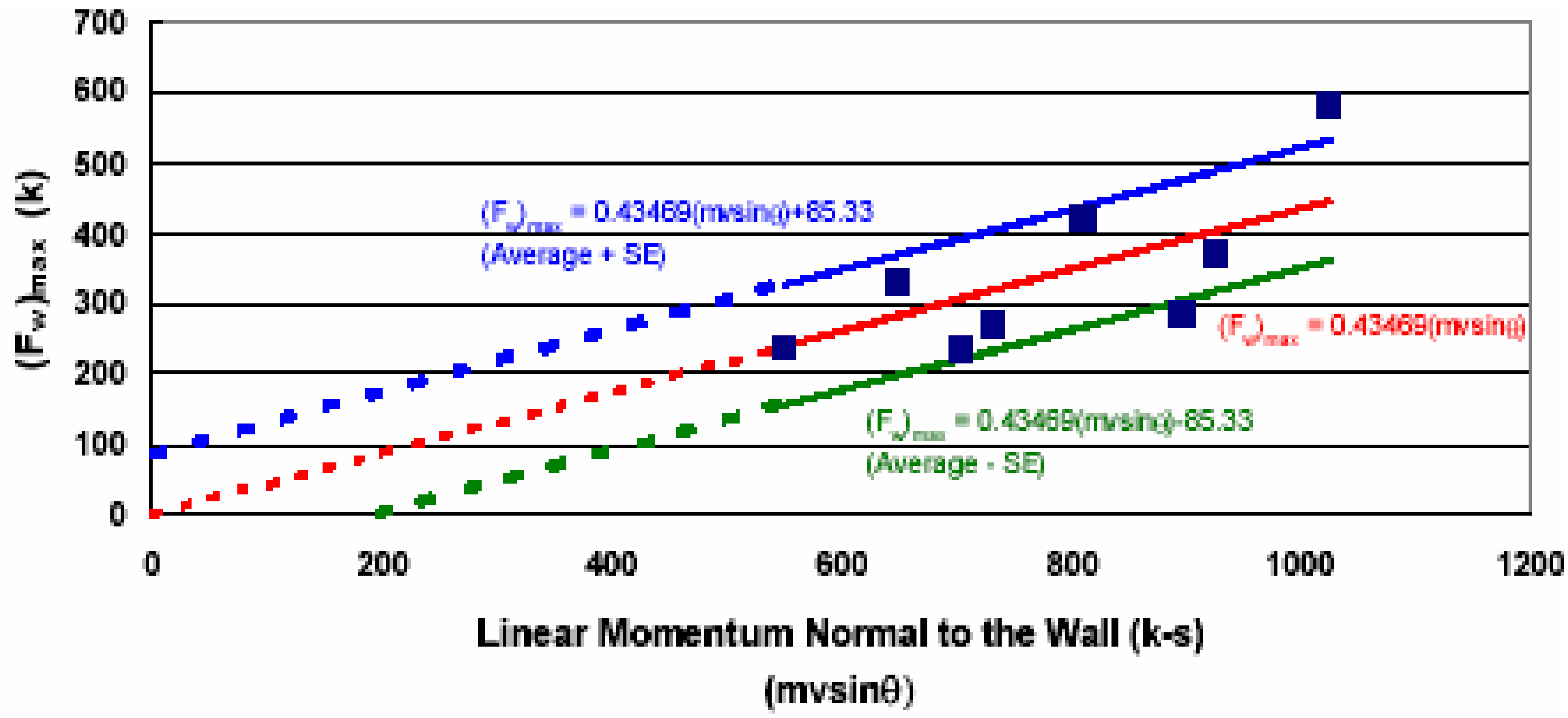
Full-Scale Experiments

- Experiment Data Reduction
  (ERDC/ITL Technical Report ITL-03-3)
  - Maximum normal force to wall from load beam measurements
  - Linear momentum of barge
    - Term "mvsinθ"
  - Develop empirical equation from experiments

Load Cell Data

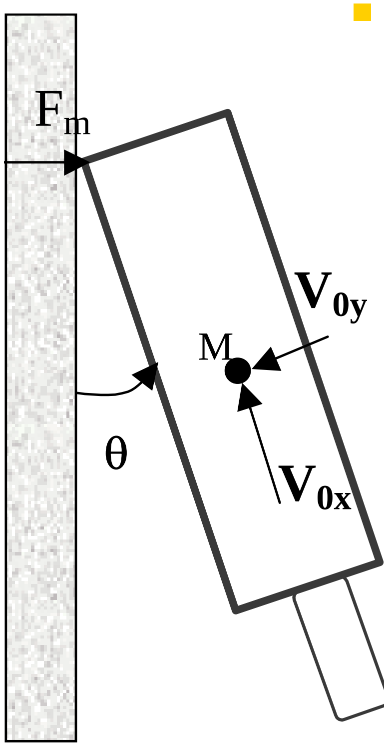


Force vs. Linear Momentum



Full-Scale Experiments

- Empirical Model
  - Limit (363 Metric Tons or 800 kips)



$$F_m = 0.435 \cdot m \cdot (V_{0x} \cdot \sin\theta + V_{0y} \cdot \cos\theta)$$

$$F_m \leq 800 \text{ kips}$$

where,

$$m = \frac{W}{2g} \quad \text{W = weight of barge train, g = 32.2 ft/sec}^2$$

V_{0x} = *initial* velocity of barge in x-direction (ft/sec)

V_{0y} = *initial* velocity of barge in y-direction (ft/sec)

θ = approach angle (degress)

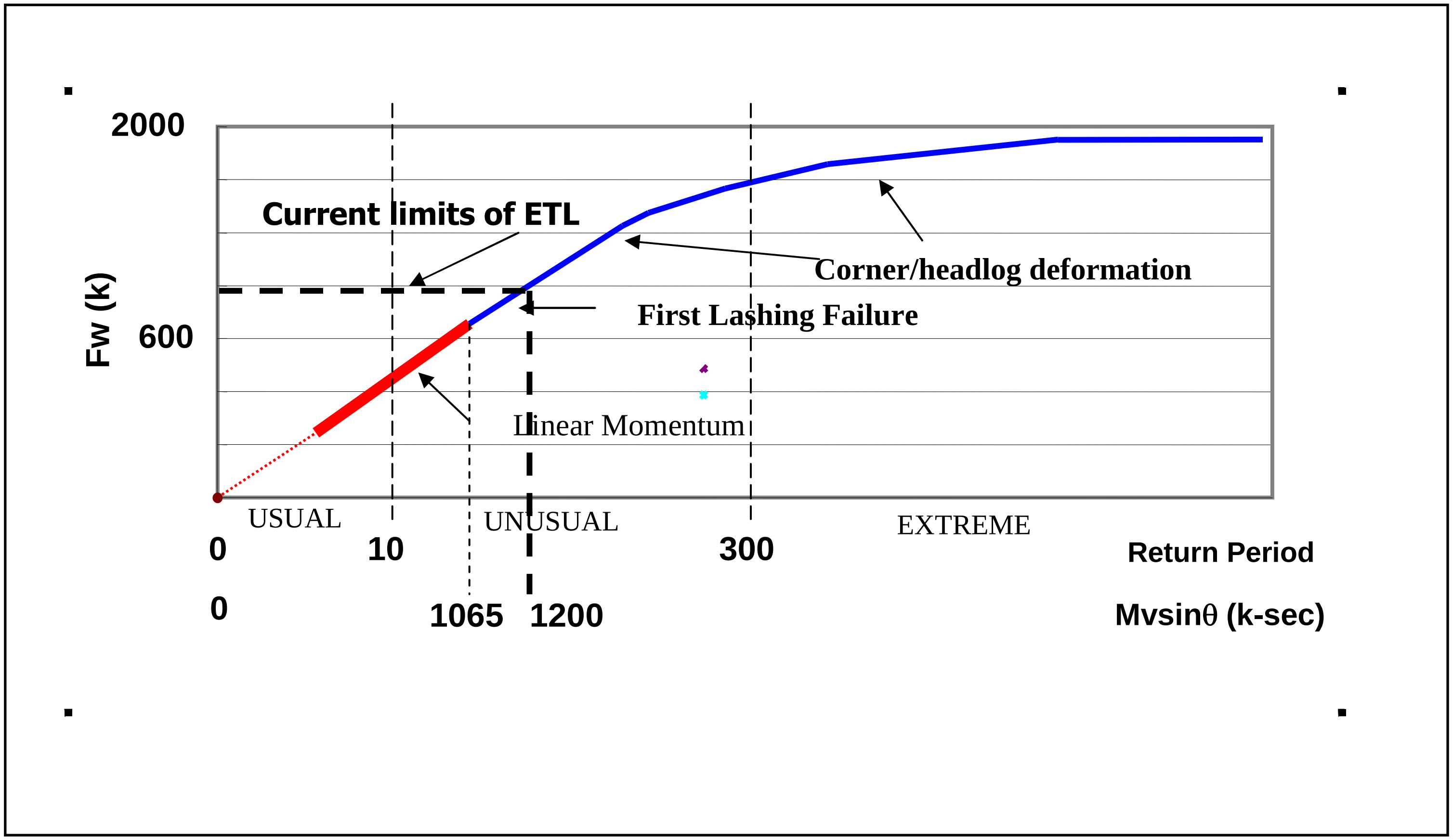
ETL 1110-2-563

- Goals of ETL 563
  - Provide an empirical model calibrated to the field experiments to assist in determining "realistic" impact forces
  - Provide guidance for input parameters to empirical model
  - Define return periods for barge impact
  - Provide methodology for determining return periods using probabilistic procedures

ETL 563

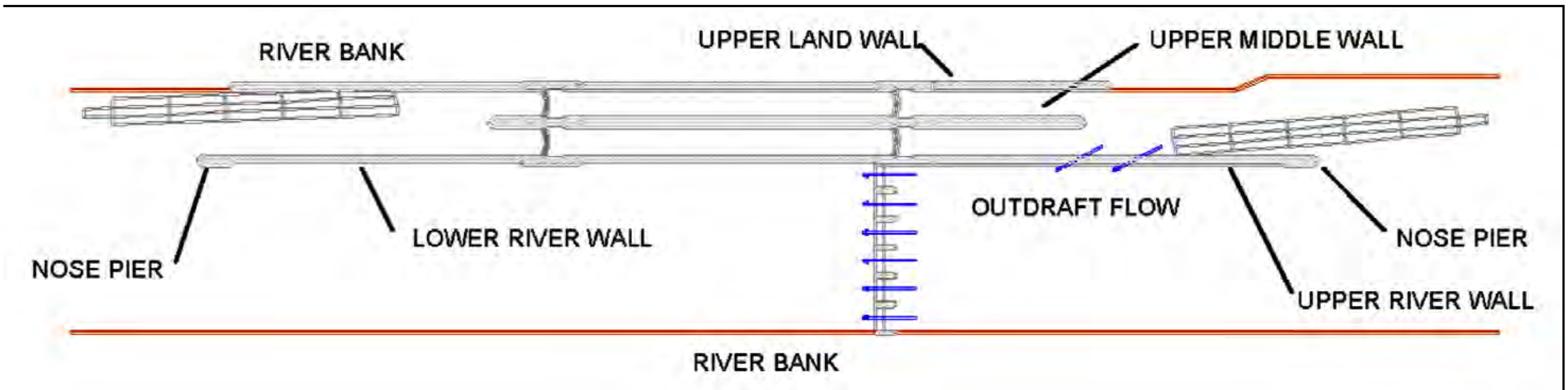
- Guidance complete but still a work in progress, works for most design requirements
  - Current model based on linear momentum of controlled impact experiments
    - Limitations of experiments
  - Future empirical or analytical models will account for:
    - Lashing Failures
    - Head-on Impacts
    - Flexible Walls

ETL 563 - Upper Limit



Barge Lashings

Typical Lock Structure



ETL 563

- Structure of ETL 563
  - HQ Guidance Letter
  - Appendix A – References
  - Appendix B – Design Guidance for Barge Impact Loads on Rigid Walls
    - Introduction
    - Empirical Barge Impact Model
    - Return Periods for Barge Impact
      - Probabilistic Barge Impact Analysis
    - Parameters for Barge Impact
    - Barge Impact Design for Rigid Walls

ETL 563

- Structure (cont')
  - Appendix C – Data from Previous Studies
  - Appendix D– Examples of Probabilistic Barge Impact Analysis for Rigid Walls
  - Appendix E – Empirical Method for Barge Impact Analysis for Rigid Walls
  - Appendix F – Field Experiments
- Other issues addressed in ETL
  - Site constraints – limits angles and velocities
  - Drag and cushioning effects
  - Angular velocities
  - Added hydrodynamic mass

ETL 563

- Definition of Return Periods
  - *Usual* –
    - These loads can be expected to occur frequently during the service life of a structure, and no damage will occur to either the barge or wall. This typically corresponds to a 50 percent chance of being exceeded in any given year.
  - *Unusual* –
    - These loads can be expected to occur infrequently during the service life of a structure, and minor damage can occur to both the barge and wall. This damage is easily repairable without loss of function for the structure or disruption of service to navigation traffic. This typically corresponds to a 50 percent chance of being exceeded within a 100-year service life.
  - *Extreme* –
    - These loads are improbable and can be regarded as an emergency condition, and that moderate to extreme damage can occur to the wall and barge without complete collapse of structure (i.e., structure is repairable but with a loss of function or with an extended disruption of service to navigation traffic). This typically corresponds to a 10 percent chance of being exceeded within a 100-year service life.

ETL 563

Table 1 **Preliminary Level Design** **Return Periods for Barge Impact**		
Load Condition Categories	**Annual Probability of Exceedence**	**Return Period**
Usual	Greater than or equal to 0.1	1-10 years
Unusual	Less that 0.1 but greater than 0.00333	10-300 years
Extreme	Less than 0.00333	>300 years

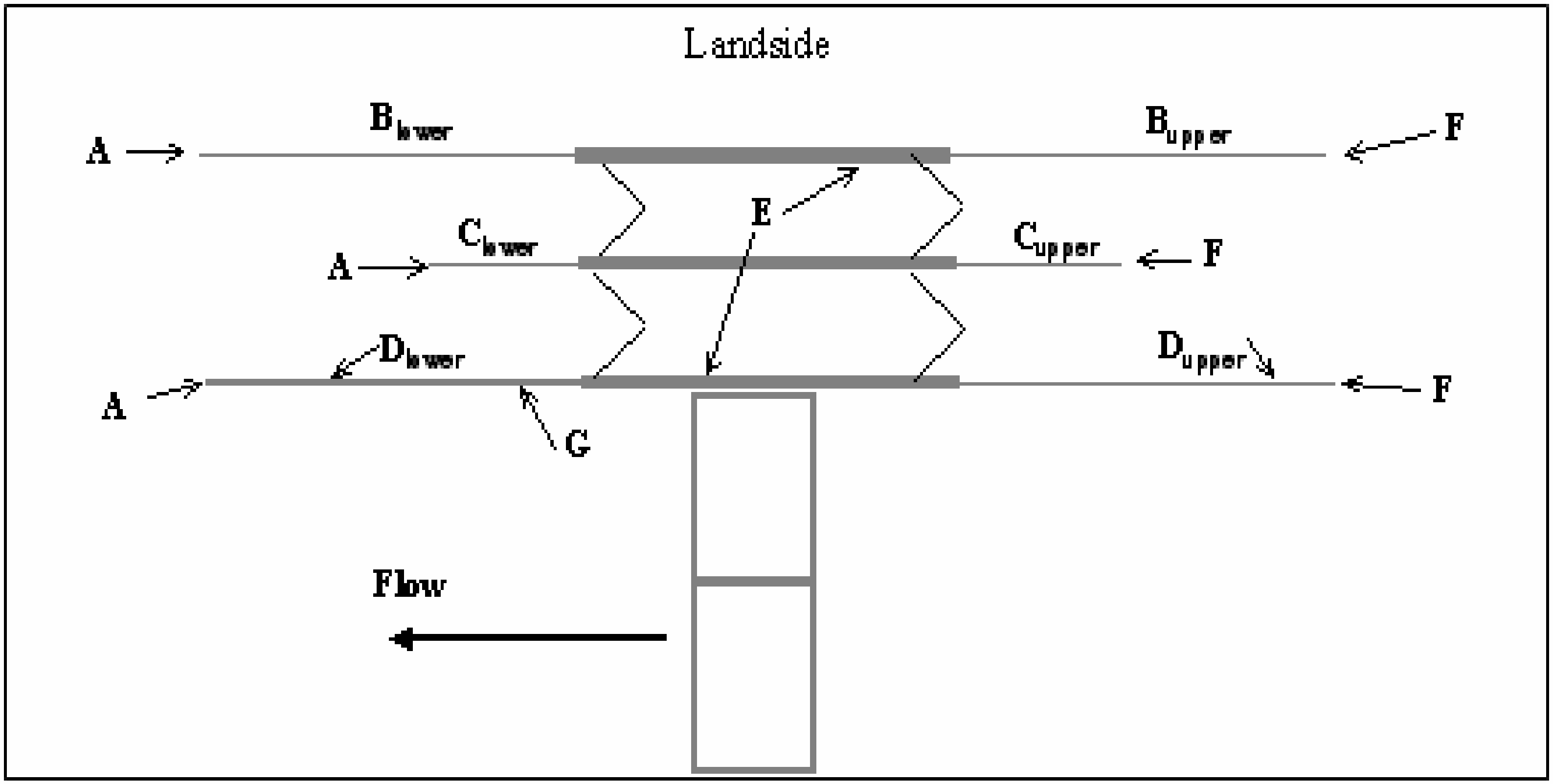
ETL 563

- Return periods

  - Probabilistic Barge Impact Analysis (PBIA)
    - Similar to Probabilistic Seismic Hazard Analysis (PSHA)
    - Uses annual probability distributions for velocities, angle and mass
    - Uses Monte Carlo Simulation to assists with determining the return period (RP) or annual probability of exceedance, P(E)

$$RP = 1 / P(E)$$

Examples of impact loads on lock structures



To convert kips to kilonewtons, multiply by 4.448

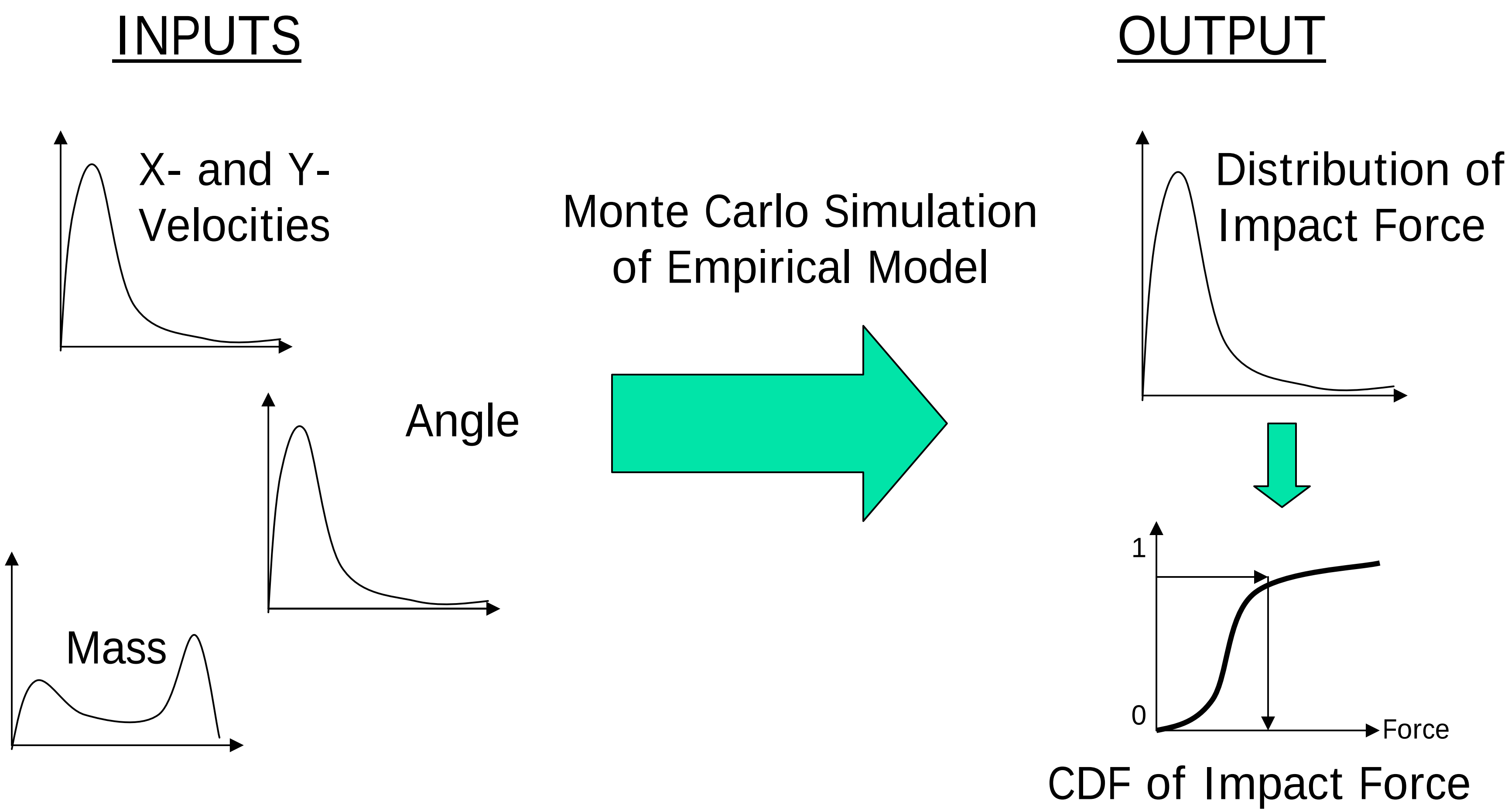
Table B-5
Example of Preliminary 9-Barge Design Impact Forces and Locations

Symbol (Figure B-10)	Location	Event	Impact Load, kips
A	Lower protection cell/bullnose	Extreme	1,000
B_{lower}	Lower land wall	Usual	150
		Unusual	250
		Extreme	350
B_{upper}	Upper land wall	Usual	300
		Unusual	500
		Extreme	700
C_{lower}	Lower middle wall	Usual	100
		Unusual	150
		Extreme	250
C_{upper}	Upper middle wall	Usual	200
		Unusual	300
		Extreme	500
D_{lower}	Lower river wall	Usual	200
		Unusual	300
		Extreme	400
D_{upper}	Upper river wall	Usual	400
		Unusual	600
		Extreme	800

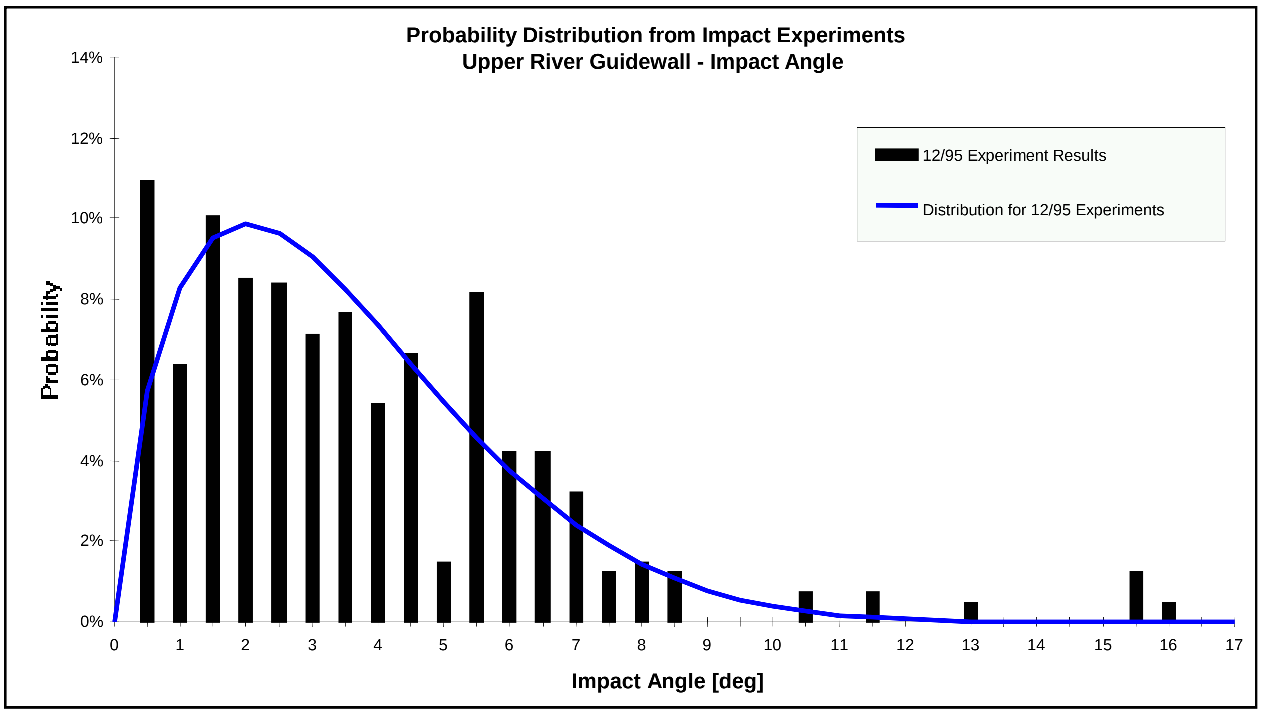
ETL 563

- Model Parameters
  - Velocity (x- and y-direction) and Angle
    - Scale model testing
    - Time lapse video
  - Mass
    - LPMS or WBC, Ship Logs
  - Site Examples in Appendix C

ETL 563

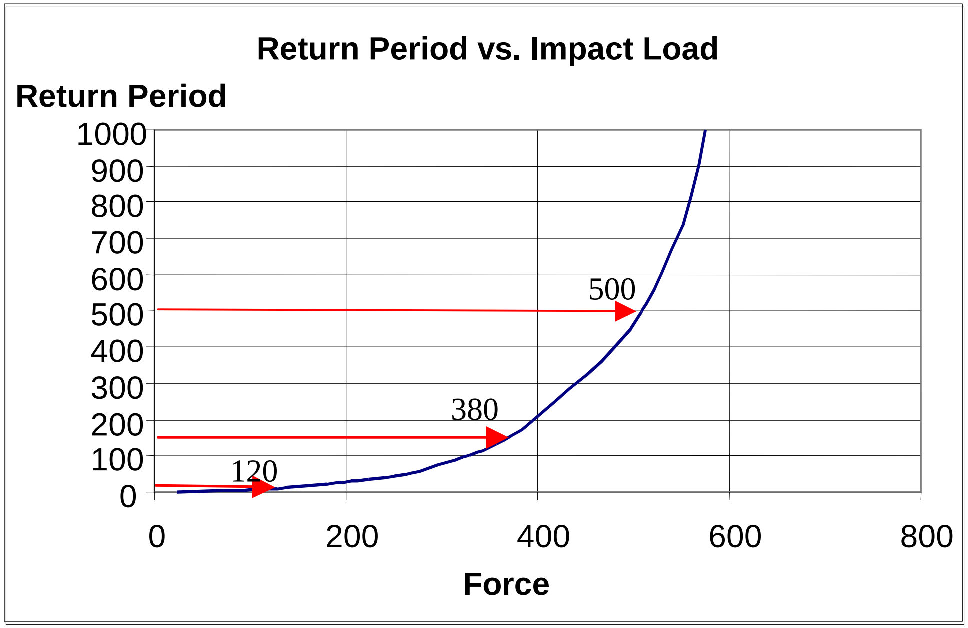

INPUTS
OUTPUT
X- and Y-
Velocities
Angle
Mass
Monte Carlo Simulation
of Empirical Model
Distribution of
Impact Force
1
0
Force
CDF of Impact Force

Example of Angle Distribution



Return period versus impact load for upper guide wall

- 120 Usual, 380 Unusual, 500 Extreme



ETL 563

- PBIA Example
  - Velocities and angles from scale model test results at ERDC
  - Mass distribution from LPMS or WBC data
  - Use Monte Carlo Simulation to generate distribution for impact load
  - Use Cumulative Distribution Function (CDF) of impact loads to determine return periods for design
    - No extrapolation to extreme distributions

Continuing Efforts

- Additional limit states
  - Lashing failures
  - Flexible Walls
  - Head-on impacts
    - Updates to ETL or new guidance
- Districts/Division-wide workshops
  - Hands-on training
  - Site specific analysis
- Computer programs
  - @Risk spreadsheet
  - Development of CASE Program

Barge Impact Analysis for Rigid Lock Walls

QUESTIONS

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US Army Corps
of Engineers
Huntington District

Belleville Locks & Dam

Barge Accident on 6 Jan 05

John Clarkson

US Army Corps of Engineers
Huntington District

Belleville Barge Accident

- Salvage Operations
- Lessons Learned
- Preventive measures considered to lessen the chances of losing pool in the event of future barge accidents.

BARGE ACCIDENT

- On January 6, 2005 the M/V Jon Strong, a twin screw towboat was up bound with 12 loaded barges.
- Nine of the barges drifted down into the dam.
- Four of the barges went through the dam gates, however, five of the barges lodged or sank against the dam piers.

Barge Location

- **AEP 8815 – sank against the pier between Gates 3 and 4**
- **AEP 8823 – lodged against the pier between Gates 4 and 5.**
- **PEN 207 – wrapped around the pier between Gates 6 and Gate 7.**
- **AEP 611 – lodged against the pier between Gates 6 and 7.**
- **MEM 94256 - lodged against the pier between Gates 6 and 7.**

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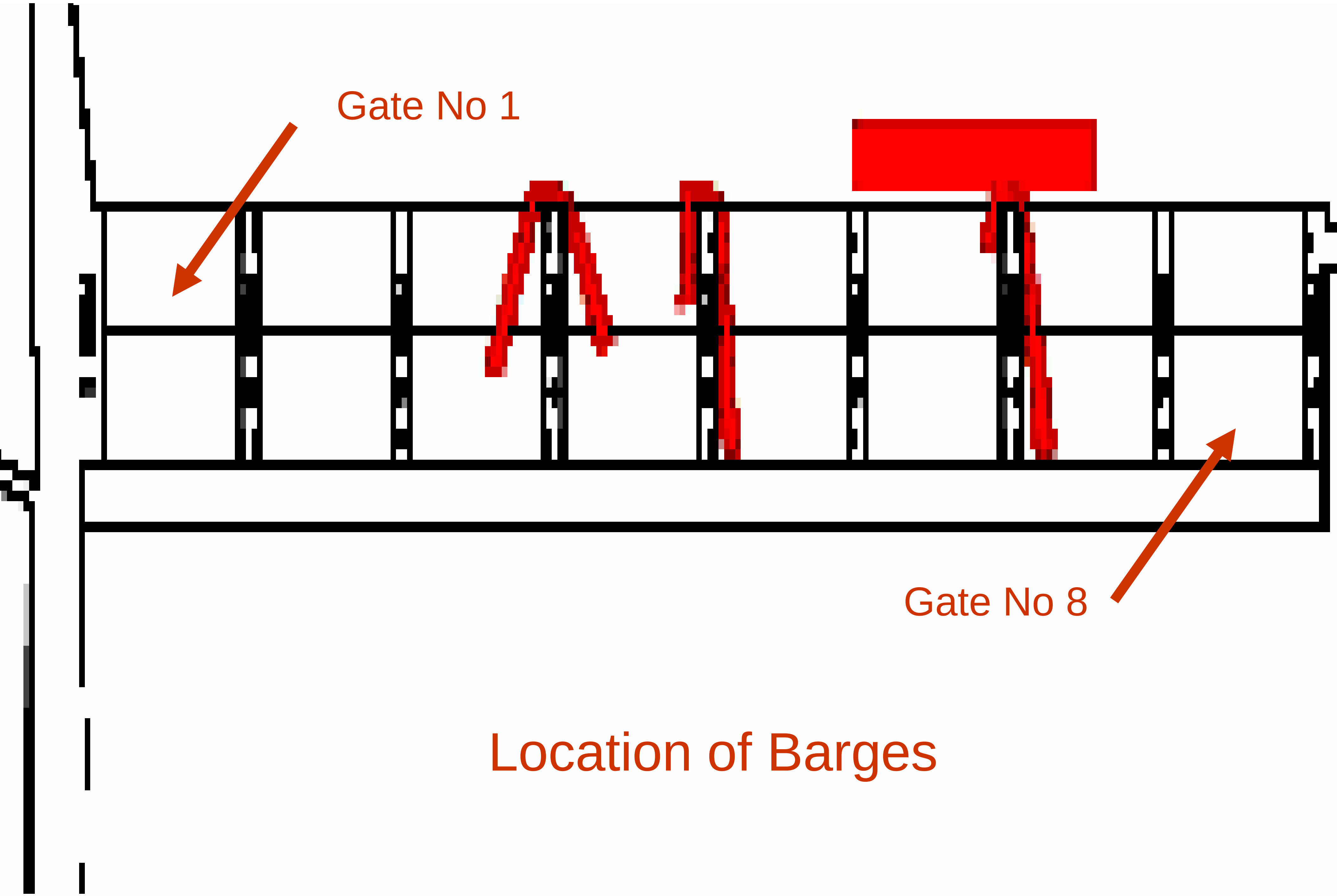
Belleville Barge Accident

- The barge accident blocked 5 of the 8 gatebays.
- The effects of the subsequent pool loss to the area caused approximately 5 million dollars a day in damages.

BARGE ACCIDENT, cont

- Heavy Rains had caused flood conditions, the dam gates raised out of the water.
- High water allowed for some lockages to continue, Locks closed to traffic for two of the four weeks
- Loss of pool aided salvage operations


Gate No 1
Gate No 8
Aerial View of Belleville Locks and Dam


Gate No 1
Gate No 8
Location of Barges

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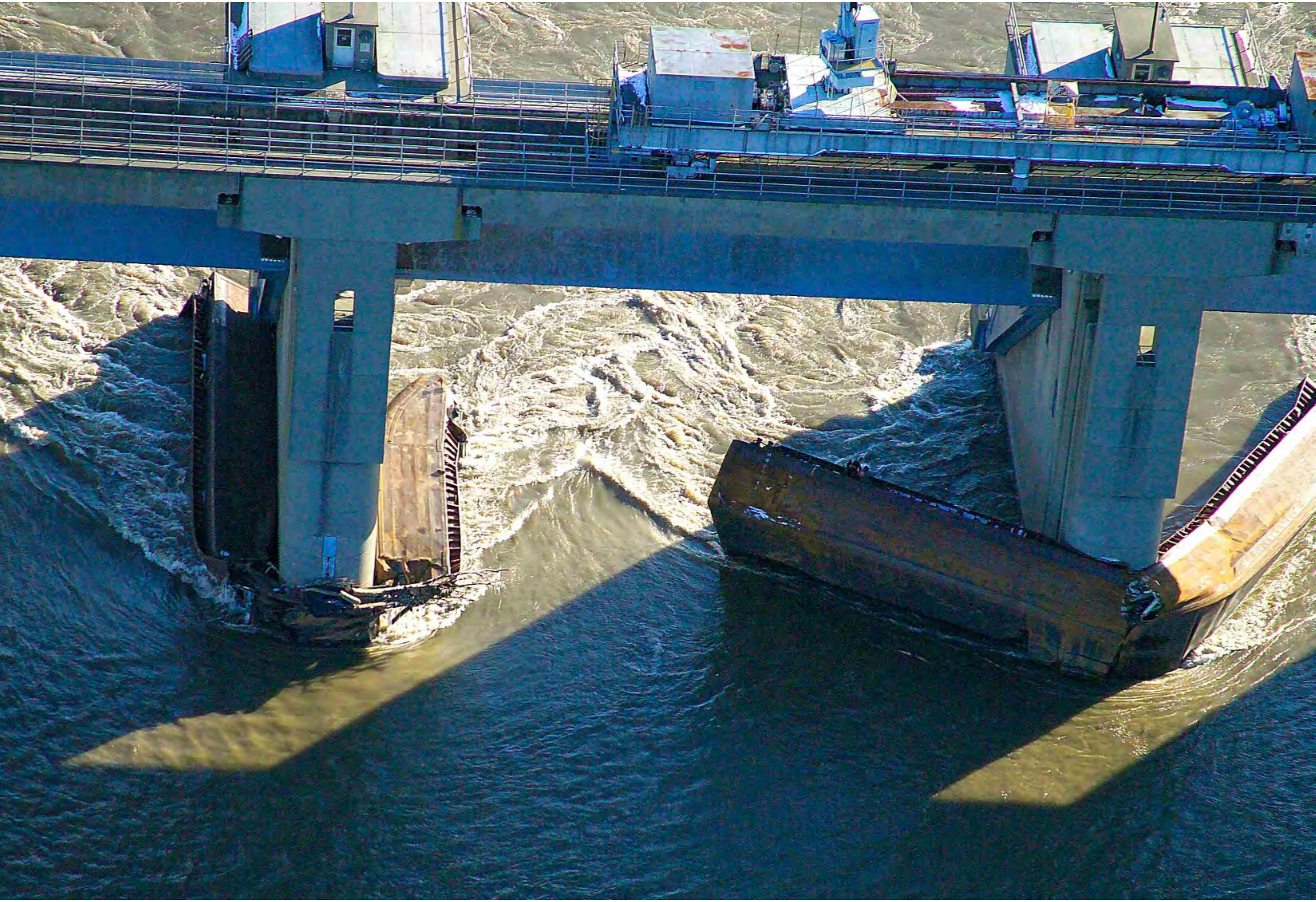
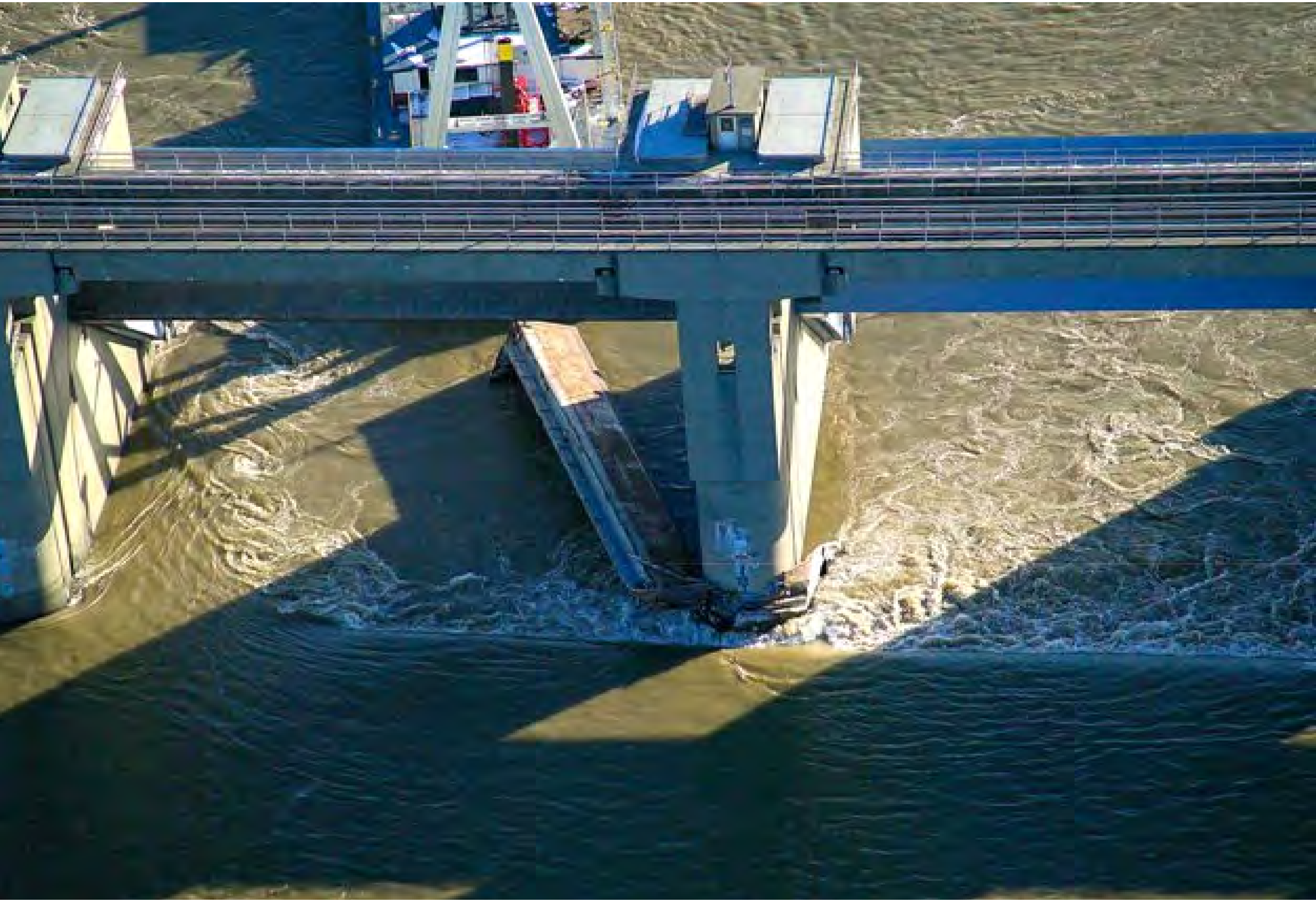
Huntington District

Belleville Locks & Dam

- **Tow Boat Operator responsible for hiring 2 salvagers to remove barges.**
- **Assembled Belleville Team, Included Industry, Coast Guard and the Corps.**


MEM
94256





Belleville Locks & Dam

Get salvage equipment onsite as quickly as possible before loss of pool prohibits transport.

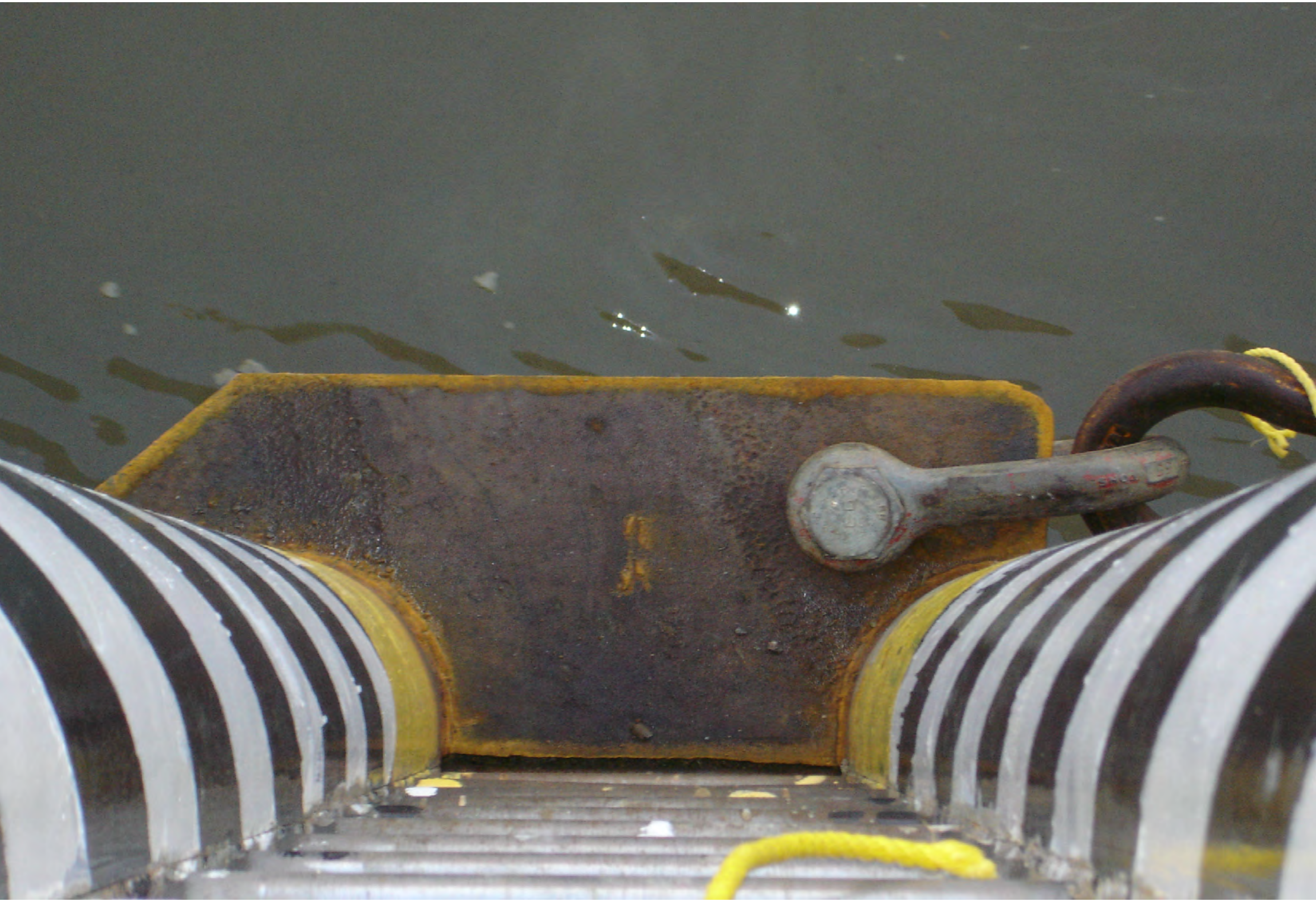
Salvager's Equipment

- **2 towboats 4176 kilowatt (5600 HP)**
- **454 metric ton (500 ton) A-frame crane**
- **Pulling barge**
- **Hydraulic shear**
- **Cutting beam**
- **Numerous other smaller cranes, A-frame cranes, and barges**

Various Concepts to Remove the Barges

- **Pull Barges Upstream off the Dam**
- **Pull and Lift Barges Downstream**
- **Cutting Beam**
- **Hydraulic Shear**
- **Underwater Cutting by Divers**
- **Pull Downstream with Three Towboats**
- **Lift out with Bulkhead Crane**


Pull from Upstream
Need to install pad-eye



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Huntington District

One Corps, One Regiment, One Team

Salvage Equipment Upriver

River Salvage digging with a crane to anchor a barge with winches to lower down their excavator with a hydraulic shear

)kie Moore
Equipment:
Crane barge
pulling barges
M/V Capt. Val

M/V James
Moorehead


2 in (5cm) pulling cables being installed


15

Pull and lift barges from downstream


GE CO

US Army Corps
of Engineers
Huntington District

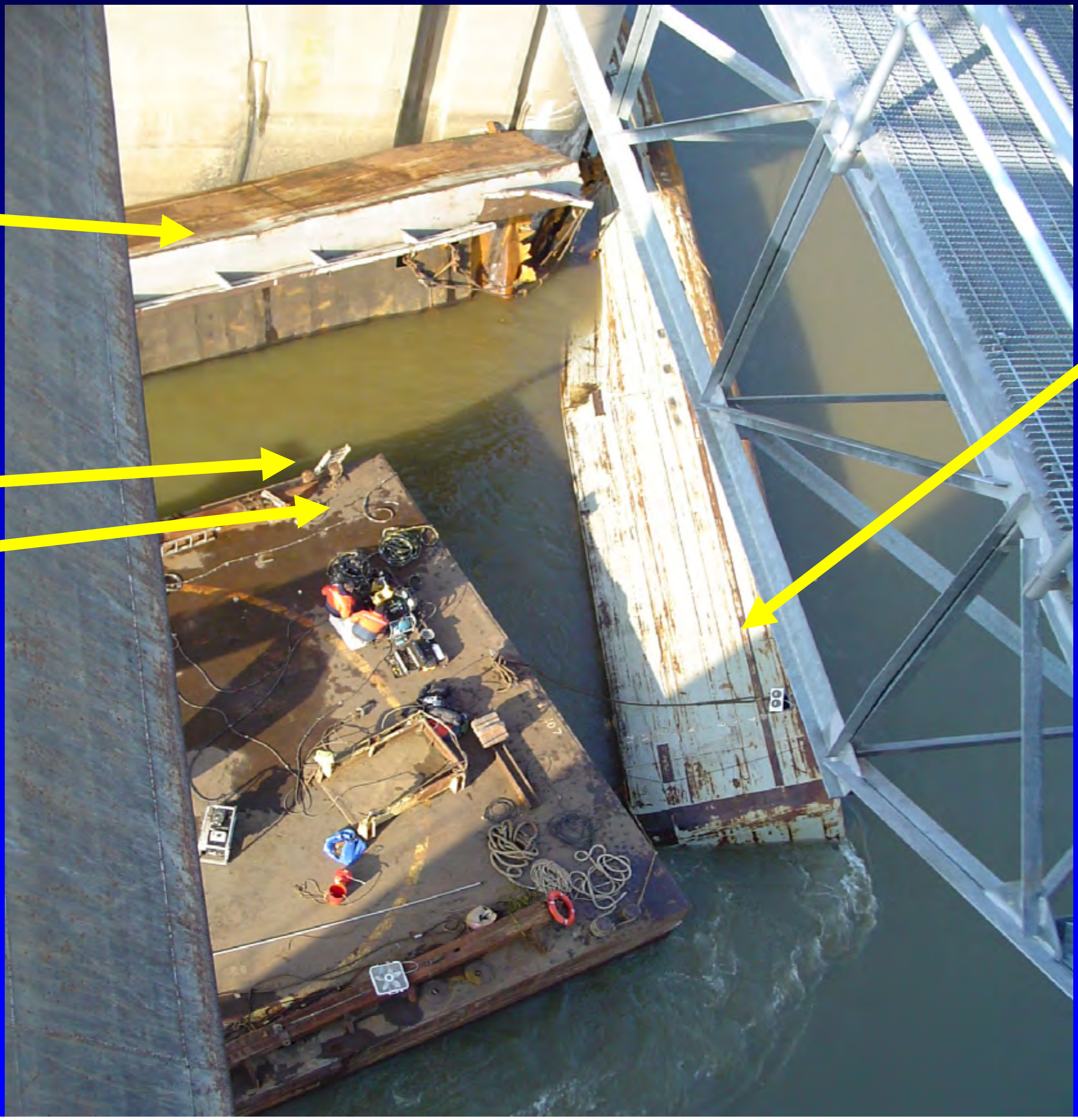
Cutting Beam and Pile Driver

- **Started to use cutting beam (Successfully used by the Louisville District) Ultimately not used, only had one barge that might be able to use, restriction that the beam could not extend beyond pier**

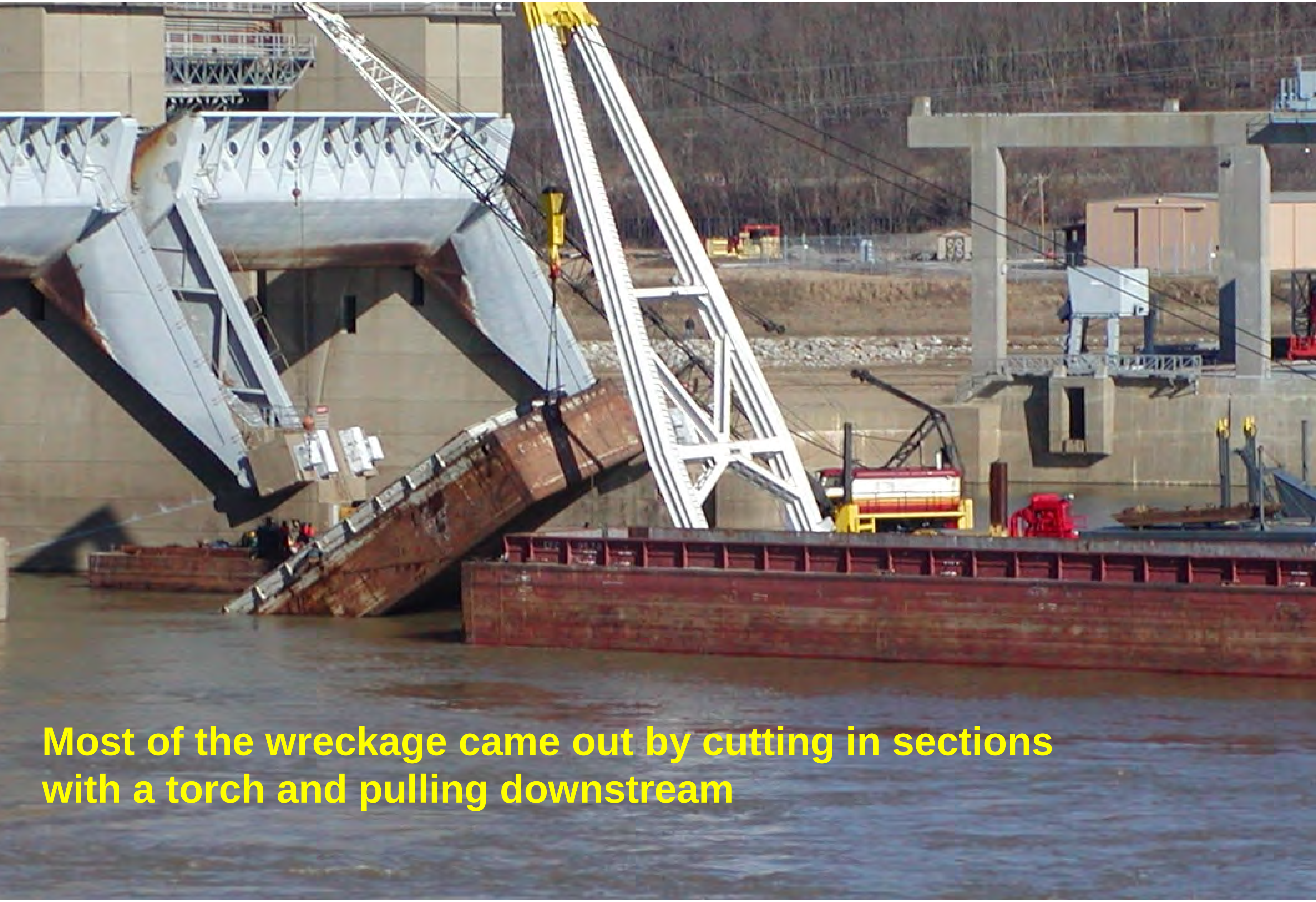

Cutting torch is the salvagers most useful tool

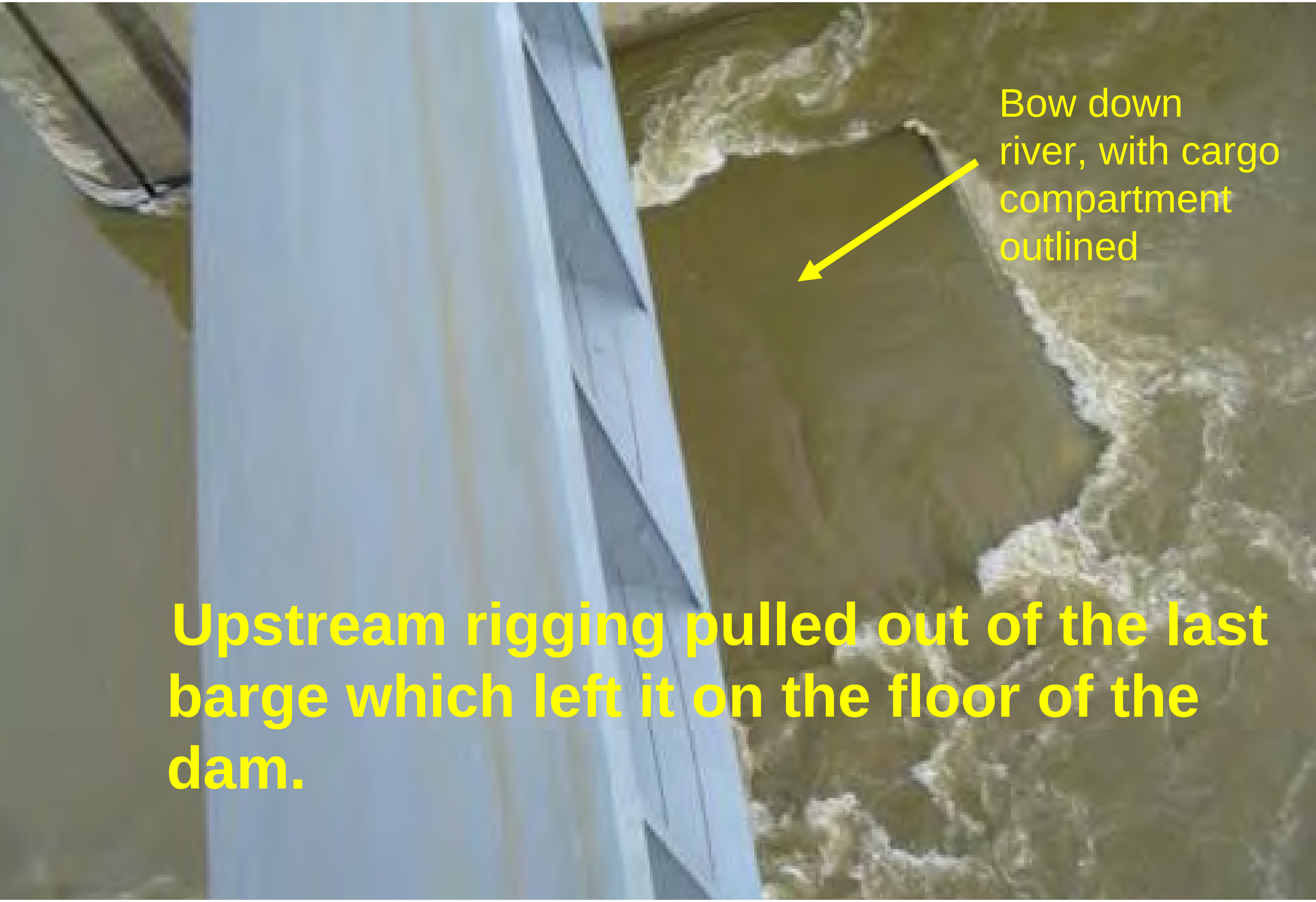

Hydraulic shear
KOMATSU

Divers cutting PEN 207




EFC
After 17 days of trying, the first of 5 gates was cleared


Most of the wreckage came out by cutting in sections
with a torch and pulling downstream


Bow down
river, with cargo
compartment
outlined
Upstream rigging pulled out of the last
barge which left it on the floor of the
dam.

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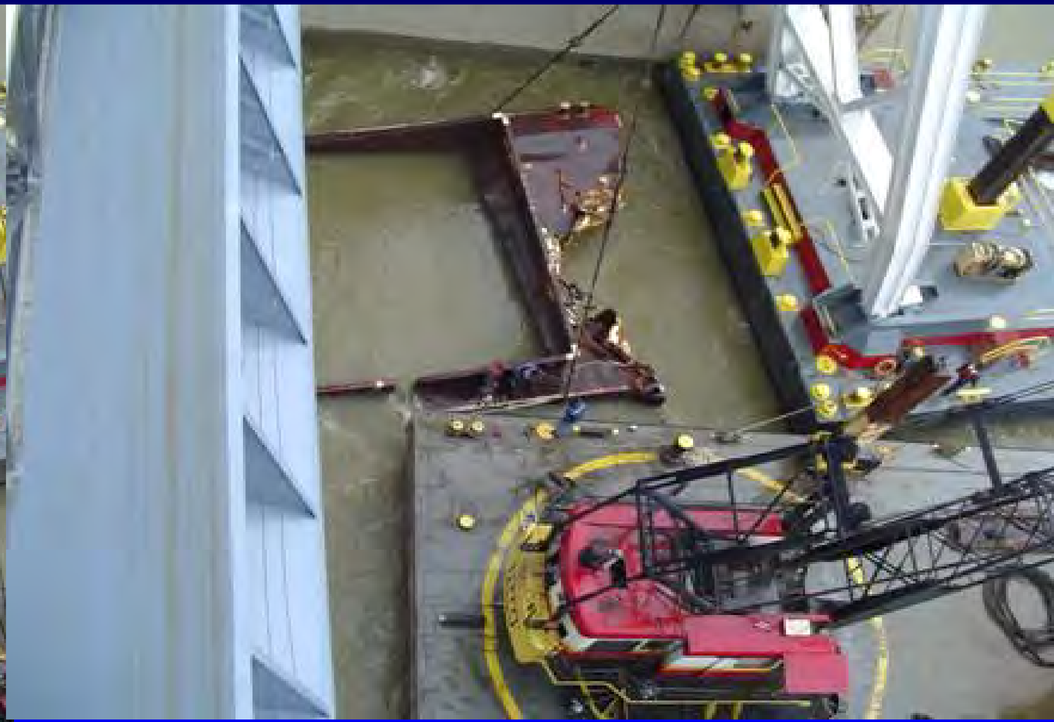
Huntington District

One Corps, One Regiment, One Team

Saturday, Jan 29th



Worked a sling under the bow of AEP 8815.

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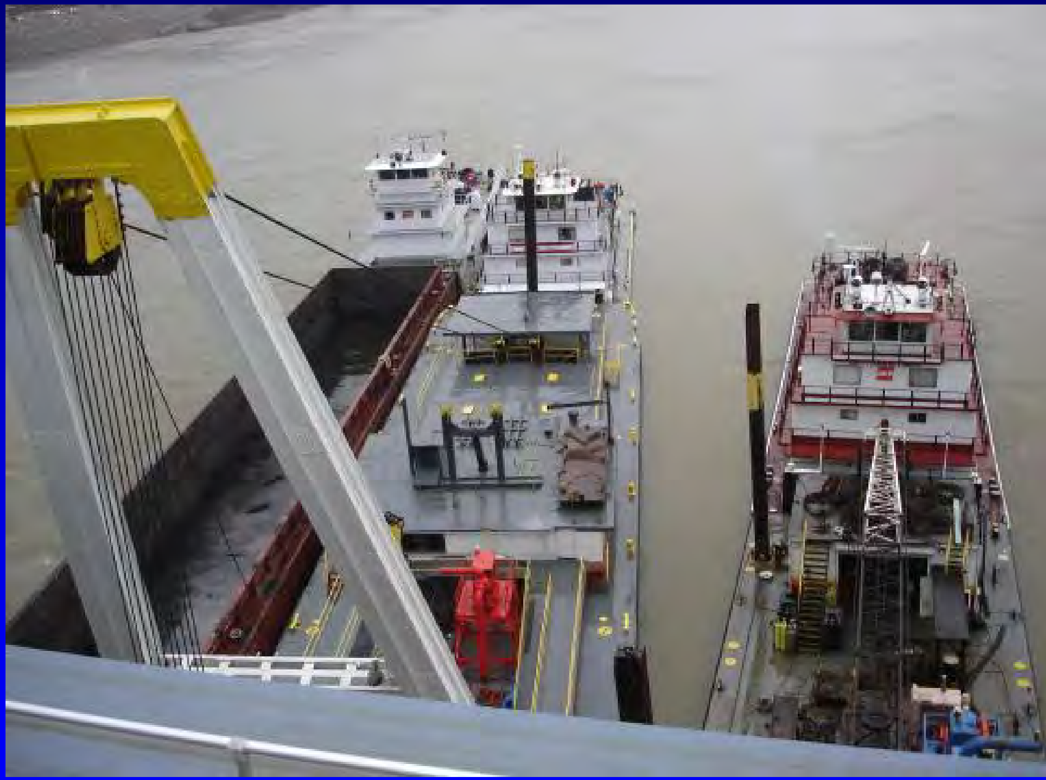
of Engineers
Huntington District

Last Barge

- **Running out of options and tried pulling the downstream rigging with three towboats. While unsuccessful, there was some movement, the barge appeared to be hung up on a part of the dam sill.**



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Lifting out with Bulkhead Crane and the 454 metric ton (500 ton) A-frame to lift the barge. The salvager raised one end of the barge with the A-Frame crane and worked a sling under the mid-section to rig to the dam's bulkhead to lift the other end out of the water and then cut the barge into two pieces.


KOMATSU

M/Vs Capt John Reynolds and James Garret coordinated the movement out of Gate 3 and down river.

Finally, after 26 days the locks reopened

Queues at the lock increased to a total of fifty-three (53) towboats waiting


ANDY MULLINS
ANDY MULLINS

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Huntington District

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Past Accidents

Smithland Locks and Dam

Cheatham Locks and Dam

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Past Accidents

Columbia Lock and Dam

Pipe to Protect Diver from Current

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Huntington District

Maxwell Locks and Dam

Barge Accident Study

- Studying modern era pool loss accidents to find commonalities.
- Preventive measures are being considered to lessen the chances of losing pool in the event of future barge accidents.

Barge Accident Study, cont.

- The preferred solution would be transported via roadway to quickly get onsite and be deployed with minimum if any floating plant (working barge). It would also be universal and could be used at many lock projects.
- Several options are being considered, including an integrated pile driver/cutting beam that can move across the gate bay.

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Belleville Barge Accident

QUESTIONS

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Seismic Requirements for Arch, Mech, and Elec. Components

2005 Infrastructure Systems Conference

Track 14, Session 14C
Wednesday 3 August 2005

Presented by John Connor, USACE, Kansas City District

US Army Corps of Engineers

Presentation Outline

- Purpose
- Criteria Overview
- UFC 3-310-04 Requirements
- UFC vs. ASCE
- Design Considerations
- Specifications (01492, 13080, 15070, 16070)
- Future directions
- Q & A

Purpose

- New Criteria (UFC)
- Plans and Specs conflict
- Design vs. Performance Spec
- Least design attention, Most RFI's
- Criteria conflict/confusion
- Circular references
- Roles & Responsibilities not clear

Criteria Overview

- UFC 1-200-01 (Gen. Bldg. Req.)
- UFC 3-310-01 (Structural Load Data)
- UFC 3-310-04 (Draft Seismic Design)
- IBC 2003
- ASCE 7-02
- UFGS
- FEMA, NEHRP, TI 809-04?

UFC 1-200-01

- "Design: General Building Requirements"
- 20 June 2005 (supercedes 31July 2002)
- Rescinds TI-809-04
- Directs IBC 2003 for Seismic
- Directs UFC 3-310-01 for site data and bldg category
- Directs Seismic design per IBC Chapter 16 as modified by UFC 3-310-04.

IBC 2003, Chap. 16

- Section 1621 "A/M/E Component Seismic Design Requirements"
- Directs to use ASCE 7-02, Section 9.6, "A/M/E Components and Systems"
  - Based on NEHRP 2000 (FEMA 368)

UFC 3-310-01

- "Structural Load Data"
- 25 May 2005
- Ss, S1 values for CONUS/OCONUS installations
- New SUG IV and Occupancy Category V

UFC 3-310-04

- “Seismic Design for Buildings”
- 24 June 2005 *(draft)*
- Modifications to IBC 2003, Chap 16
- In general, Supplemental Info and Optional Designs
- Provides criteria for new SUG IV “Strategic Assets”

UFC 3-310-04

- **App B: Modifications to IBC Chap 16.**
- **App C: Alternate, Simple Systems**
- **App D: Alternate, for SUG III**
- **App E: Design for SUG IV**
- **App F: Guidance for A/M/E Components**

UFC 3-310-04, App B

- Modifications to IBC Chap 16.
- A/M/E Comp: Additions to ASCE 7, Section 9.
- Generally, adds wording for SUG IV requirements
- "All provisions for components having an Ip=1.5 shall also apply to SUG IV components.

UFC 3-310-04, App C

- "Simplified Alternative Structural Design Criteria for Simple Bearing Wall or Building Frame Systems"
- Simplifies Lateral Force Analysis Procedure
- No change for A/M/E components, same as conventional analysis

UFC 3-310-04, App D

- Alternate Design Procedure for SUG III
- Optional non-linear analysis
- May provide more economical designs
- Apply only with approval of authorizing design agency
- Modifies ASCE 7, Sec 9.6 equations considering MCE and SE, using NSP and NDP.

UFC 3-310-04, App E

- Design for SUG IV
- i.e. Key defense assets & NBC facilities
- Components remain elastic, operational, for MCE
- ASCE 4-98, "Seismic Analysis of Safety-Related Nuclear Structures".
- A/M/E components based on in-structure response spectra, developed from models of primary structures and MCE.

UFC 3-310-04, App E

- Classify all components as MC1, MC2, or NMC
- MC1: Mission Critical, operable immediantly. Certified.
- MC2: Mission Critical, minor damage (repair in 3 days).
- NMC: Non-mission critical, will not have falling hazards or impede egress.

UFC 3-310-04, App F

- Guidance for A/M/E Components
- The "Commentary to ASCE 7-02, Section 9.6"
- Details for veneer, floor mounts, suspended systems, and pipe supports
- Walk-down inspections and equipment qualifications (III, IV)

UFC vs. ASCE

- **ASCE**: A/M/E Comp. design based on SDC and Ip.
- **UFC**: A/M/E Comp. design based on SUG

- **SUG**: I, II, III, IV (Bldg importance)
- **SDC**: A, B, C…SDC is a function of SUG, Site Class (A, B…), and Ground Motion (Ss, S1)
- **Ip**: Component Importance Factor (1.0, 1.5)

UFC vs. ASCE

- **ASCE: Ip of the component determines if design is necessary**
- **UFC: Implies that SUG III, IV of the bldg applies to the components as well.**

Example: Fire station, Camp Dodge, IA

SUG=III, Ss=0.07, S1=0.04, Site Class=D

>>>SDC=A<<<

UFC vs. ASCE

SUG	III	III	III	III
SDC	C	C	A	A
Ip	1.0	1.5	1.0	1.5
ASCE	Exempt	Design	Exempt	Exempt
UFC	Design	Design	Design	Design

Design Considerations

- In-house, Government designer
- A/E designed
- Contractor designed

Design Considerations

In-house, A/E Design

- Based on assumed equipment and layout
- Objective/defined
- One detail for all cases
- Consider for small/simple projects

Contractor (A/E hired)

- Based on as-built condition
- Subjective/debatable
- Can choose best for job
- Burden/cost for small companies

Project Documents

- Coordinate with specs
- Coordinate with other disciplines
- What is intent of showing details?
- Fully designed, or suggested details?
- Add notes to cover contingencies
- Quality Assurance (see next track)
  - ASCE 7-02, Table 9.6.1.7
  - Walk down inspections
  - Component certification
  - Roles of inspectors/EOR/owner

Specifications

- Currently reference TI-809-04, FEMA 302
- SUG, but not SDC
- Ip needs to be defined
- 01492: Special Inspection for Seismic-Resisting Systems
- 13080: Seismic Protection for Misc. Equip.
  - Used as baseline for 15070 and 16070.
  - Misc. Equipment or Architectural?
  - Items not covered: partitions, veneer, ceilings
- 15070: Seismic Protection for Mech. Equip.
- 16070: Seismic Protection for Elec. Equip.

Future Directions

- Review draft UFC (3-310-04).
  - Clarify SUG vs. SDC, Ip.
  - Tools, checklists, flowcharts (App G)
- Update Specs (13080, 15070, 16070).
  - Incorporate IBC & UFC
  - Establish multi-discipline proponents
  - Master Spec
- Communities of practice (CoP).
  - Arch, Mech, Elec, and Struct.

Questions?

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Quality Assurance for Seismic Resisting Systems

2005 Infrastructure Systems Conference

Track 14, Session 14C
Wednesday 3 August 2005

Presented by John Connor, USACE, Kansas City District

Presentation Outline

- Purpose
- Criteria Overview
- IBC Requirements
- UFC 3-310-04 Requirements
- Specification 01492
- Future directions
- Q & A

Purpose

- New Criteria (UFC)
- “Construction’s Job”, “Not Applicable”
- Criteria confusion
- Circular references
- Roles & Responsibilities not clear
  - Owner
  - Building Official
  - Registered Professional

Criteria Overview

- UFC 1-200-01 (Gen. Bldg. Req.)
- UFC 3-310-01 (Structural Load Data)
- UFC 3-310-04 (Draft Seismic Design)
- IBC 2003
- ASCE 7-02
- UFGS 01492

UFC 1-200-01

- “Design: General Building Requirements”
- 20 June 2005 (supercedes 31July 2002)
- Rescinds TI-809-04
- Directs UFC 3-310-01 for site data and bldg category
- Directs IBC 2003 for Seismic
- Tests and Inspections per IBC Chapter 17 as modified by UFC 3-310-04.

UFC 3-310-01

- “Structural Load Data”
- 25 May 2005
- Ss, S1 values for CONUS/OCONUS installations
- New SUG IV and Occupancy Category V

IBC 2003, Chap. 17

- **Section 1705 "Quality Assurance for Seismic Resistance"**
- **Section 1707 "Special Inspections for Seismic Resistance"**
- **Section 1708 "Structural Testing for Seismic Resistance"**

IBC 1705, (Quality Assurance)

- QA Plan required for SDC C, D, E, F.
- Exception for
  – light-framed wood/steel
  – Reinforced masonry <25', Sds<0.5g
  – Detached family dwelling
- QA Plan prepared by registered design professional.

IBC 1705, (Quality Assurance)

- QA Plan shall identify:
  - Seismic systems
  - Special Inspections
  - Type and frequency of testing
  - Type and frequency of inspections
  - Distribution of testing and insp reports
  - Structural observations and reports

IBC 1705, (Quality Assurance)

- Contractor shall acknowledge:
  - Requirements of QA Plan
  - Conformance to construction documents
  - Procedures for control within Contractor's organization, the method and frequency of reporting, and distribution of reports.
  - Identification and qualifications of persons

IBC 1707 (Special Inspections)

- Continuous: "Full time observation of work…by an approved special inspector who is present in the area where work is to be performed.
- Periodic: "Part-time or intermittent observation of work… by an approved special inspector who is present in the area where work has been or is being performed. "

IBC 1707 (Special Inspections)

- Owner (or Agent) shall employ 1 or more special inspectors
- Special Inspector: "qualified person…for inspection of the particular type of construction requiring inspection".
- UFC 3-300-10N: QC Specialist for NAVFAC projects
- Corps projects: Con-Rep, RE
- Contractor hires independent inspector

IBC 1707 (Special Inspections)

- Required for: SDC C, D, E, F
- Steel: Cont. Insp. of welding >5/16”.
- Wood: Cont. Insp. of gluing operations, Periodic Insp. of fastening components.
- Cold-Formed: Periodic Insp. of welding and fasteners.
- Storage Racks: Periodic Insp. of anchorage to floors.

IBC 1707 (Special Inspections)

- Architectural Components (SDC D, E, F)
- Periodic inspection of fastening of:
  - Exterior cladding
  - Interior & Exterior non-bearing walls
  - Interior & Exterior veneer
- Exceptions:
  - Bldgs <30' height
  - Cladding/veneer <5psf
  - Non-bearing walls <15psf

IBC 1707 (Special Inspections)

- Mech/Elec Components (SDC C, D, E, F)
- Periodic inspection of fastening of:
  - Emergency power systems
  - Piping carrying hazardous materials
  - HVAC carrying hazardous materials
- Equipment shall be labeled and tested
  - Shaking table
  - 3D shock tests
  - Rigorous analysis

IBC 1708 (Testing)

Masonry:

- Non-essential facility
  - Certificates of compliance used in construction.
  - Verification of f'm
- Essential facility (SUG III, IV)
  - Certificates of compliance used in construction.
  - Verification of f'm
  - Verification of mortar and grout materials

IBC 1708 (Testing)

- Reinforcing Steel: Certified mill test reports for steel used in:
  - Reinforced Concrete frames
  - Boundary elements of special reinforced concrete
  - Reinforced masonry shear walls

(For SDC C, D, E, F)

IBC 1708 (Testing)

- Structural Steel: as req'd by AISC 341.
- Mech/Elec Equipment
  - Test or analyze equipment and anchorage.
  - Submit certificate to design professional

(For SDC C, D, E, F)

UFC 3-310-04 (draft)

- **“Seismic Design for Buildings”**
- **24 June 2005** *(draft)*
- **Modifications to IBC 2003, Chap 17**
- **Added Definitions for Personnel Roles**
- **Incorporates SUG IV**
- **Added Walk-thru inspections for SUG III, & IV**

UFC 3-310-04 (draft)

- **Building Official**: Shall be designated by the Contracting Officer.
- **Owner**: Shall be designated by the the Contracting Officer.
- **Registered Design Professional**: PE or SE

Who: Corps, DPW, Base CE, ACSIM?

When: Designate before or after contract?

UFC 3-310-04, (draft)

- Walk-thru inspections req'd for SUG III & IV with SDC D, E, or F.
- Conducted by registered professionals prior to commissioning.
- Report of seismic vulnerabilities.
- Facility manager will implement mitigation recommendations.

Section 01492

- "Special Inspection for Seismic-Resisting Systems"
- Currently references TI-809-04, FEMA 302
- Special Inspector employed by Contractor
- No definition of Owner, PE, Building Official
- QA Plan developed by Contractor
- Periodic Inspection at least 25% of total time.
- Includes extra items from ASCE 7
- Excludes items from IBC

Future Directions

- Review draft UFC (3-310-04).
  - Improve definitions for personnel.
- Update Spec 01492
  - Incorporate IBC & UFC
  - Master Spec
- Communities of practice (CoP).
  - Structural & Construction

Questions?

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SBEDS

(Single degree of freedom Blast Effects Design Spreadsheets)

Dale Nebuda, P.E.
U.S. Army Corps of Engineers
Protective Design Center

US Army Corps of Engineers ®

Presentation Outline

- Background & general description
- SBEDS technical capabilities
- Tour of workbook
- Obtaining SBEDS
- Future enhancements

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Background

- Implementation of DoD antiterrorism construction standards requiring more blast design of 'conventional' facilities
- Existing blast resistant structural design tools developed for design of more robust structures and are cumbersome for design of more conventional structures
- USACE Protective Design Center, through Baker-Risk, developed SBEDS as a designer friendly tool for more typical construction
- SBEDS v1.0 released May 2004, v2.0 released June 2005

SBEDS - General

- SBEDS is an Excel© workbook that combines all steps to design/analyze a wide variety of blast-loaded structural components
- User inputs basic information related to geometry, boundary condition, material property, response mode, & blast load for component
- SBEDS calculates equivalent SDOF parameters & determines dynamic response w/ time-stepping SDOF calculator
- 11 types of structural components available
  - Also allows for input of general SDOF system
- Outputs maximum response parameters and response history plots

SBEDS – General (continued)

US Army Corps of Engineers ®

- **Also performs shear check**
  - **stirrup design for concrete & CMU components**
- **Iteratively develops pressure-impulse (P-i) relationship and associated charge weight-standoff diagrams**
- **Designated metric or english units**
- **Detailed Users Guide hot-linked to workbook**
- **Based on Army TM 5-1300 & UFC 3-340-01 guidance but draws on other sources for best methodologies**

Protective Design Center

US Army Corps of Engineers ®

Available Component Types

- One-way corrugated metal panel
- One-way or two-way steel plate
- Steel beam or beam-column
- One-way open-web steel joist
- One-way or two-way reinforced concrete slab
- Reinforced concrete beam or beam-column
- Prestressed concrete beam or panel
- One-way or two-way reinforced masonry
- One-way or two-way unreinforced masonry
- One-way or two-way wood panel
- One-way wood beam or beam-column
- General SDOF system

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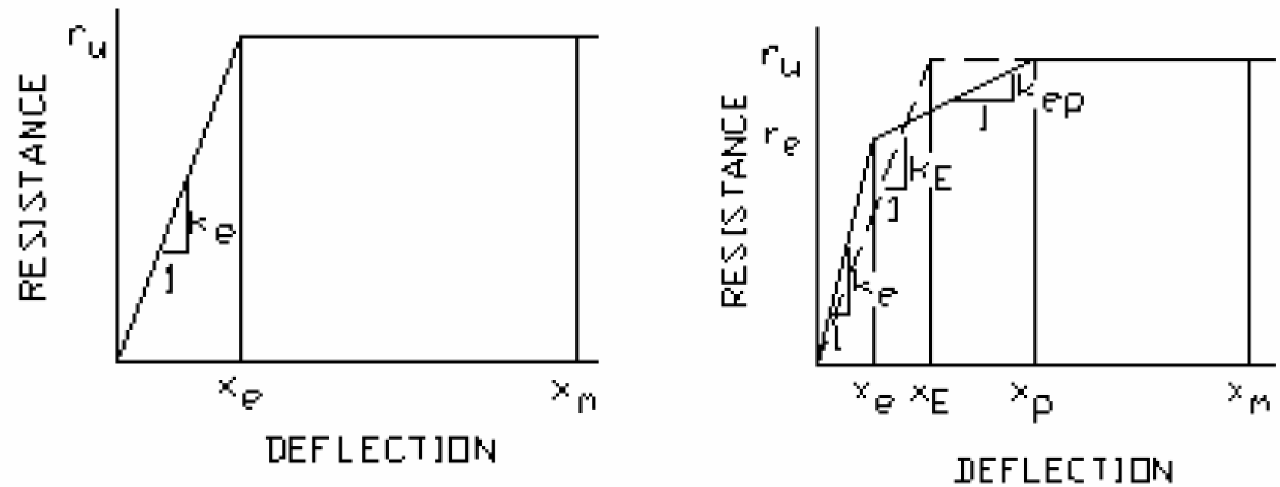
Available Response Modes

- Flexure
- Tension membrane
- Compression membrane
- Brittle flexure w/ axial load softening
- Arching with gap & non-solid section
- General

Flexure Resistance Functions

- TM 5-1300/UFC 3-340-01
- All components
- Option for shear based resistance for concrete slabs & masonry elements



Determinate Boundary Conditions

Indeterminate Boundary Conditions
(Solid Curve Used for Flexure Only)
(Dashed Curve for Flexure and Tension Membrane)

Figure 4. Resistance-Deflection Curve For Flexural Response

Tension Membrane Resistance Function

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- **UFC 3-340-01**
- **One-way corrugated metal panel**
- **One-way or two-way steel plate**
- **Steel beam or beam-column**

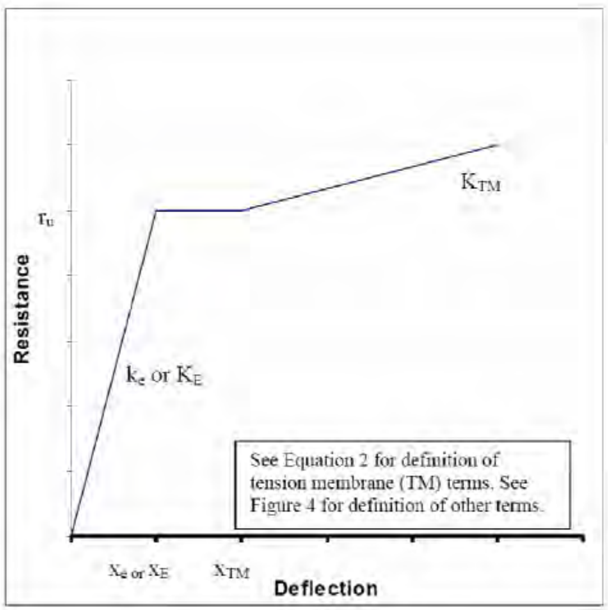

Figure 5. Resistance Deflection Curve for Steel Components with Tension Membrane

$$x_{TM} = x_E + \sqrt{\frac{4TL^2}{\pi^2 EA}} \quad \text{where} \quad T = \text{Minimum}\left[\left(f_{dy}A\right), V_c\right]$$

$$K_{TM\_1} = \frac{8T}{bL^2}$$

$$K_{TM\_2} = \frac{T\pi^3}{4L_y^2 \sum\limits_{n=1,3,5,7} \left[\frac{1}{n^3}(-1)^{(n-1)/2} A\right]} \quad \textit{where} \quad A = 1 - \frac{1}{\cosh \frac{n\pi L_x}{2L_y}} \quad \textit{and} \quad L_x \geq L_y$$

Equation 2

where:
- x_{TM} = assumed deflection at beginning of linear tension membrane response adding to flexural response for one and two-way response
- K_{TM_i} = linear tension membrane slope for one-way (i=1) or two-way (i=2) response
- x_E = equivalent elastic yield deflection
- f_{dy} = dynamic yield strength
- A = component cross sectional area within loaded width b

Protective Design Center

Compression & Tension Membrane Resistance Function

- UFC 3-340-01
- User's option to consider compression only, tension only, or both
- One-way or two-way RC slab
- RC beam or beam-column
- One-way or two-way reinforced masonry

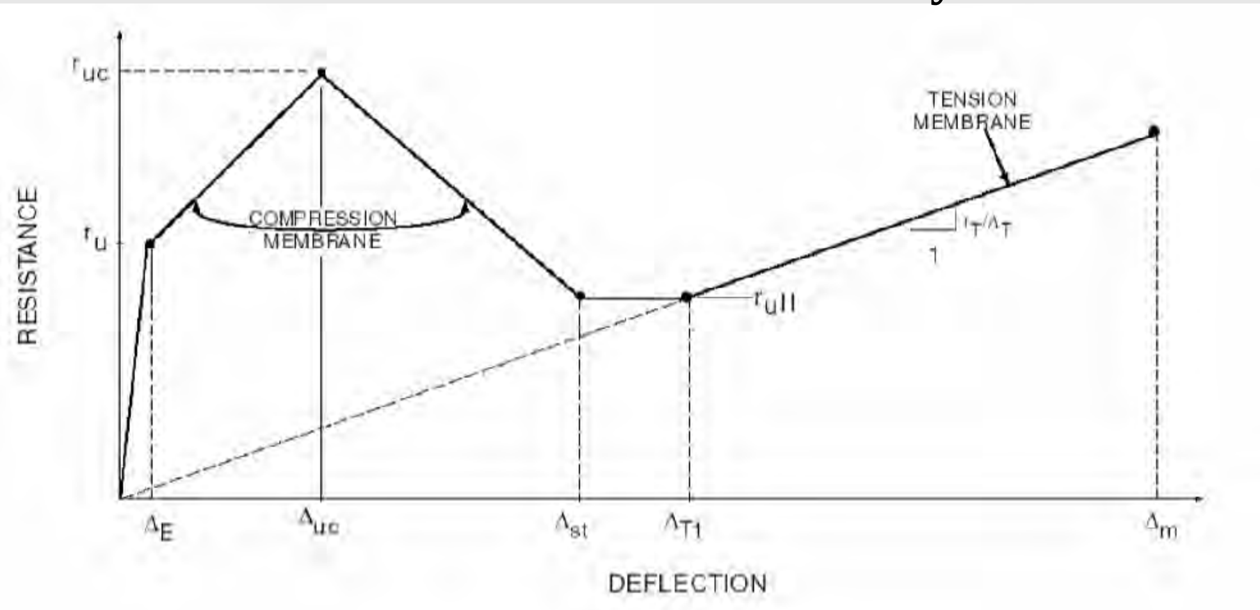

Figure 18. Resistance-Deflection Curve for Reinforced Concrete and Masonry Components with Compression and Tension Membrane (from UFC 3-340-01)

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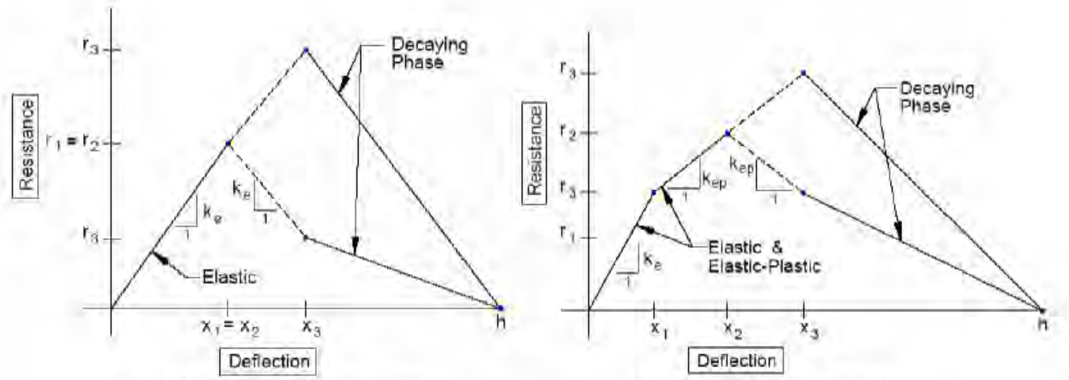
Brittle Flexure w/ Axial Load Softening Resistance Function

- **Wall Analysis Code (WAC)**
- **One-way or two-way unreinforced masonry**



Determinate Component Indeterminate Component

Figure 25. Resistance-Deflection Curves for Unreinforced Masonry with Brittle Flexural Response and Axial Load From WAC Program

$$r_3 = \frac{4}{L^2}(h - \Delta)\left(P + \frac{WL}{2}\right)$$

Equation 7

where: r_3 = maximum resistance from axial load effects

x_3 = flexural deflection at $r_2 + (r_3 - r_2)/K_{ep}$

K_{ep} = elastic-plastic stiffness for indeterminate components, otherwise equal to elastic stiffness

h = overall wall thickness

P = input axial load per unit width along wall, P_{axial}

W = areal self-weight and supported weight of wall

L = span length equal to wall height

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Arching With Gap & Non-Solid Cross Section Resistance Function

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- **Park and Gamble's <u>Reinforced Concrete Slabs</u> modified for gap between wall and rigid support for non-solid cross section**
- **One-way or two-way unreinforced masonry**

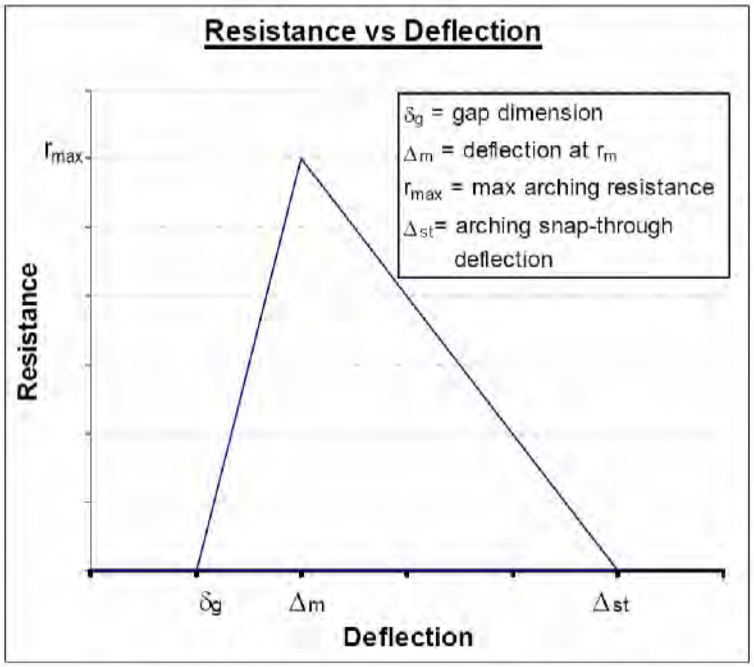

Figure 26. Arching Resistance-Deflection Curve

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General Resistance Function

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- Up to 5 segments
- Systems with or without 'softening'
- Different stiffness in rebound allowed
- Rules for rebound stiffness in systems using compressive membrane and arching

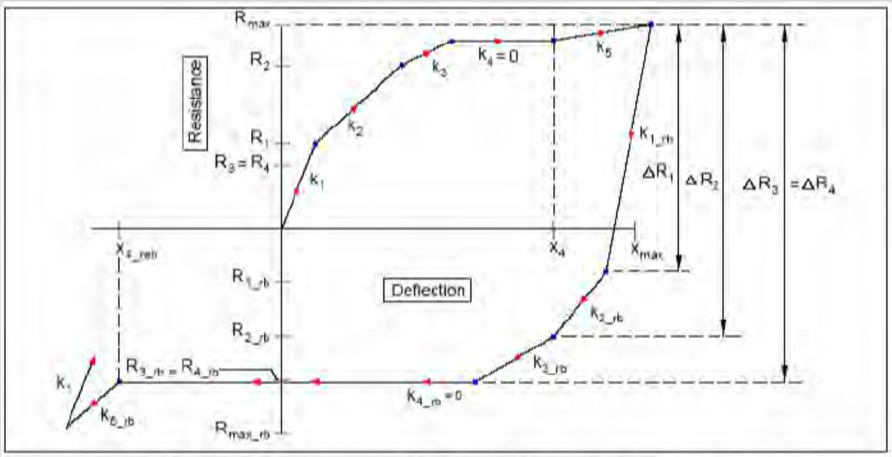

Figure 2. General Resistance-Deflection Diagram Without Softening

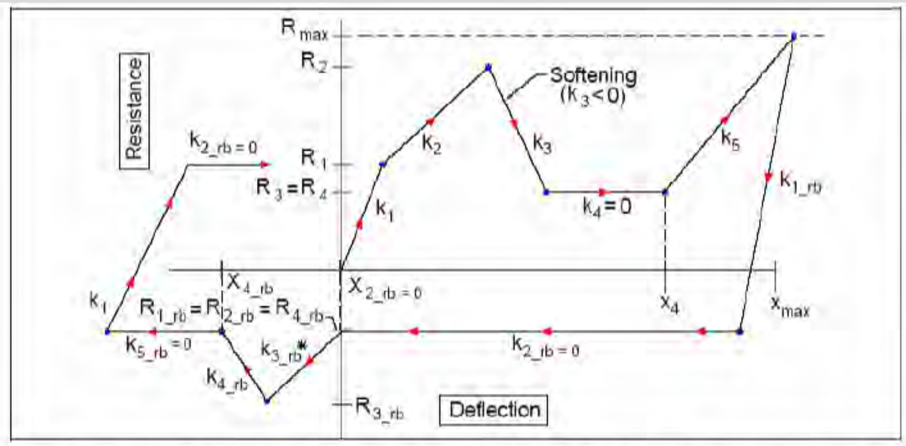

Figure 3. Typical Resistance-Deflection Diagram With Softening (See Figure 2 and Table 1 for Definition of Terms in Figure)

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Available Boundary Conditions

- **One-way components**
  - Cantilever
  - Fixed-fixed
  - Fixed-simple
  - Simple-simple (only condition for open web joists)
- **Two-way components**
  - Four sides supported (all fixed or all simple)
  - Three sides supported (all fixed or all simple)
  - Two adjacent sides supported (both fixed or both simple)

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Available Loadings

- **Uniform loading for all components**
- **Concentrated loads for beam or beam-column components**
  - **load at free end of cantilevered elements**
  - **load at midspan for all other support conditions**
- **P-Δ**
  - **RC components except prestressed**
  - **Reinforced masonry**
  - **Unreinforced masonry**
  - **Wood beam or beam-column**
  - **General SDOF**

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Equivalent P-Δ Load

- **SBEDS calculates the lateral force on component causing same maximum moment as P-Δ effect at each time step**
  - **P-Δ load based on axial load, geometry, and boundary conditions/load type of component and deflection at each time step**
- **Equivalent P-Δ load history is added to input load history and separately plotted in output**
- **Approach is consistent with other dynamic analyses methods considering P-Δ effects including FEA based approaches**

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SBEDS Structure

- ReadMe sheet
- Intro sheet
- Input sheet
- Results sheet
- P-i Diagram sheet
- SDOF Output sheet
- SDOF sheet (hidden)
- Database sheet
- Positivephasedload sheet (hidden)
- Negativephaseload sheet (hidden)
- Wait sheet

SBEDS Structure

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- ReadMe sheet
  - General admin info
  - Support info
- Intro sheet
- Input sheet
- Results sheet
- P-i Diagram sheet
- SDOF Output sheet
- SDOF sheet (hidden)
- Database sheet
- Positivephasedload sheet (hidden)
- Negativephaseload sheet (hidden)
- Wait

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SBEDS Structure

- ReadMe sheet
- Intro sheet
  - Component selection
  - Units selection
  - Workbook instructions
  - Discussion of workbook design
- Input sheet
- Results sheet
- P-i Diagram sheet
- SDOF Output sheet
- SDOF sheet (hidden)
- Database sheet
- Positivephasedload sheet (hidden)
- Negativephaseload sheet (hidden)
- Wait

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SBEDS Structure

- ReadMe sheet
- Intro sheet
- Input sheet
  - Discussed later
- Results sheet
  - Discussed later
- P-i Diagram sheet
  - Discussed later
- SDOF Output sheet
  - Sample shown later
- SDOF sheet (hidden)
- Database sheet
- Positivephasedload sheet (hidden)
- Negativephaseload sheet (hidden)
- Wait

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SBEDS Structure

- ReadMe sheet
- Intro sheet
- Input sheet
- Results sheet
- P-i Diagram sheet
- SDOF Output sheet
- SDOF sheet (hidden)
  - Time-stepping SDOF solution
- Database sheet
  - Properties of library members
  - SDOF constants
- Positivephasedload sheet (hidden)
- Negativephaseload sheet (hidden)
- Wait

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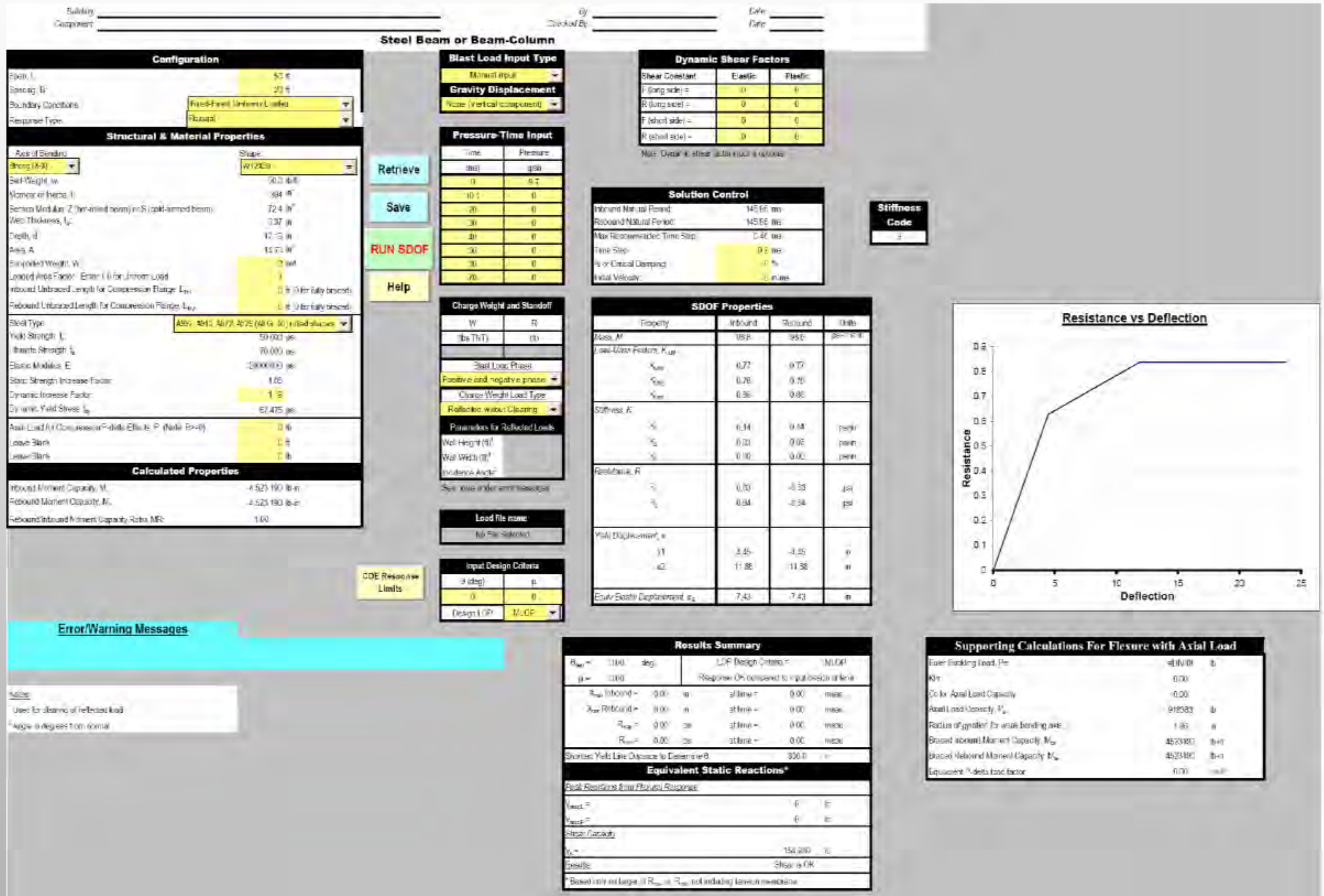
Input Sheet (Steel Beam or Beam-Column)



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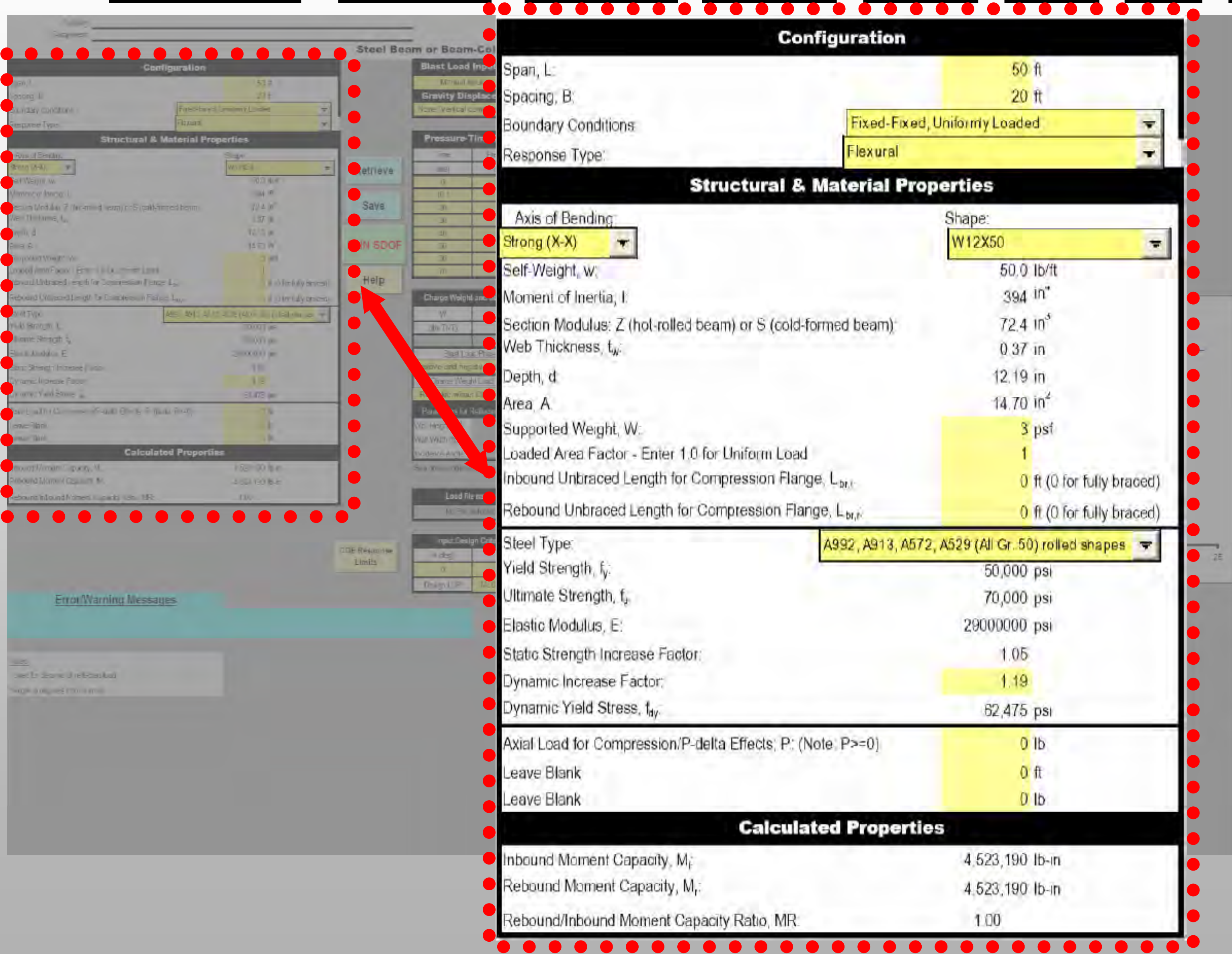
Component Input



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SBEDS Drop-Down Menus

- Support conditions
- Response mode
- Beam sizes (AISC and cold-formed girts/purlins)
- Open web steel joist sizes (K and LH series)
- Masonry (Brick, European block, Heavy-Medium-Lightweight CMU)
- Corrugated metal panel sizes (MBCI and Vulcraft sizes, traditional and standing-seam deck)
- Typ. steel plate, beam, and rebar material properties
- All drop-downs automatically insert properties of selected size/type into spreadsheet
- User-defined option available for all drop-down menus

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Calculated Resistance-Deflection Relationship on Input Sheet

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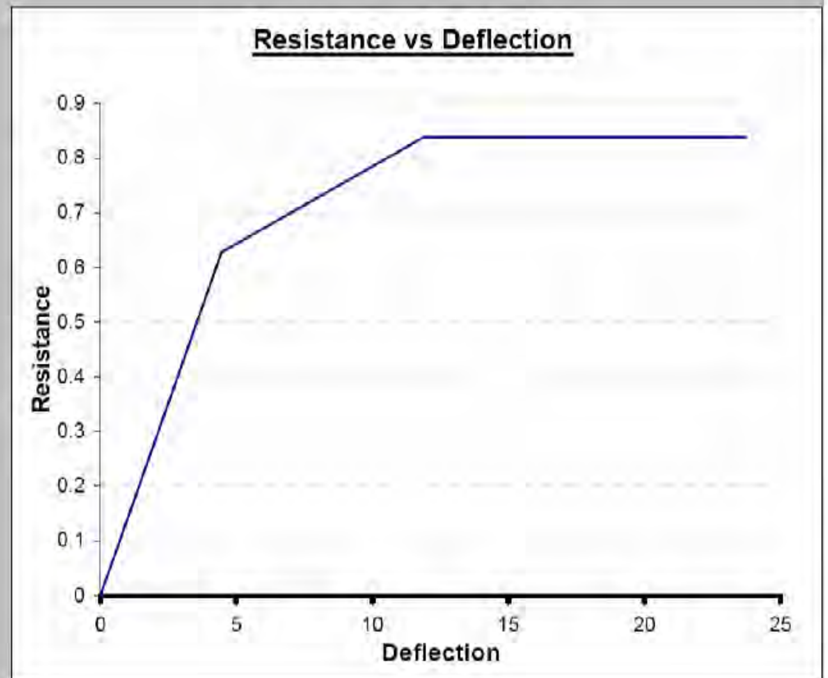
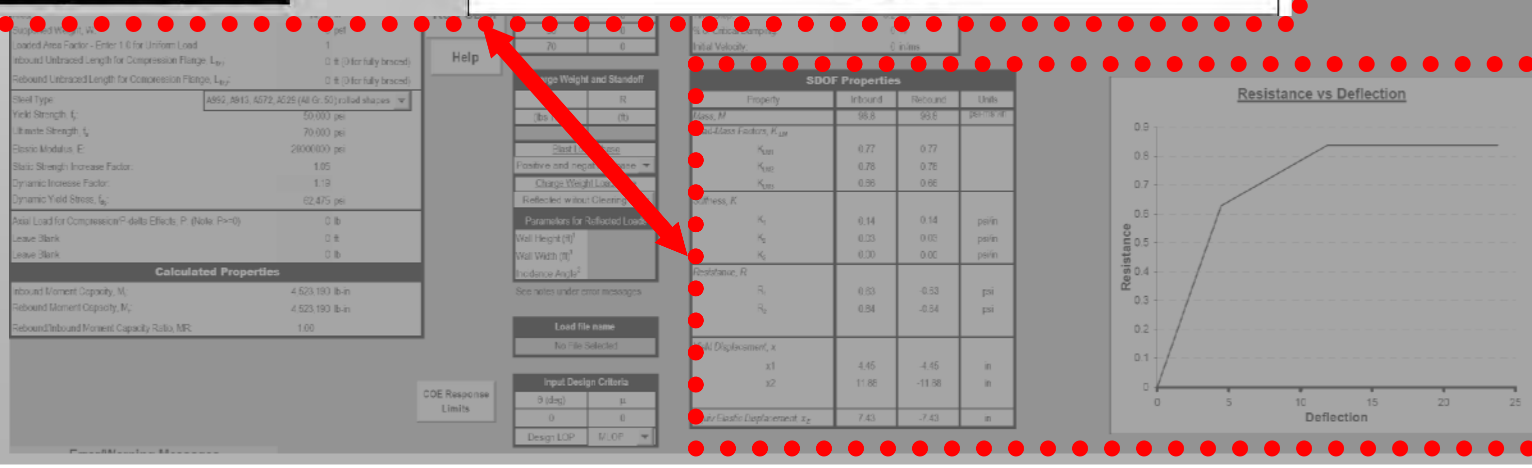
SDOF Properties			
Property	Inbound	Rebound	Units
Mass, M	98.8	98.8	psi-ms²/in
Load-Mass Factors, K_{LM}			
K_{LM1}	0.77	0.77	
K_{LM2}	0.78	0.78	
K_{LM3}	0.66	0.66	
Stiffness, K			
K_1	0.14	0.14	psi/in
K_2	0.03	0.03	psi/in
K_3	0.00	0.00	psi/in
Resistance, R			
R_1	0.63	-0.63	psi
R_2	0.84	-0.84	psi
Yield Displacement, x			
x1	4.45	-4.45	in
x2	11.88	-11.88	in
Equiv Elastic Displacement, x_E	7.43	-7.43	in





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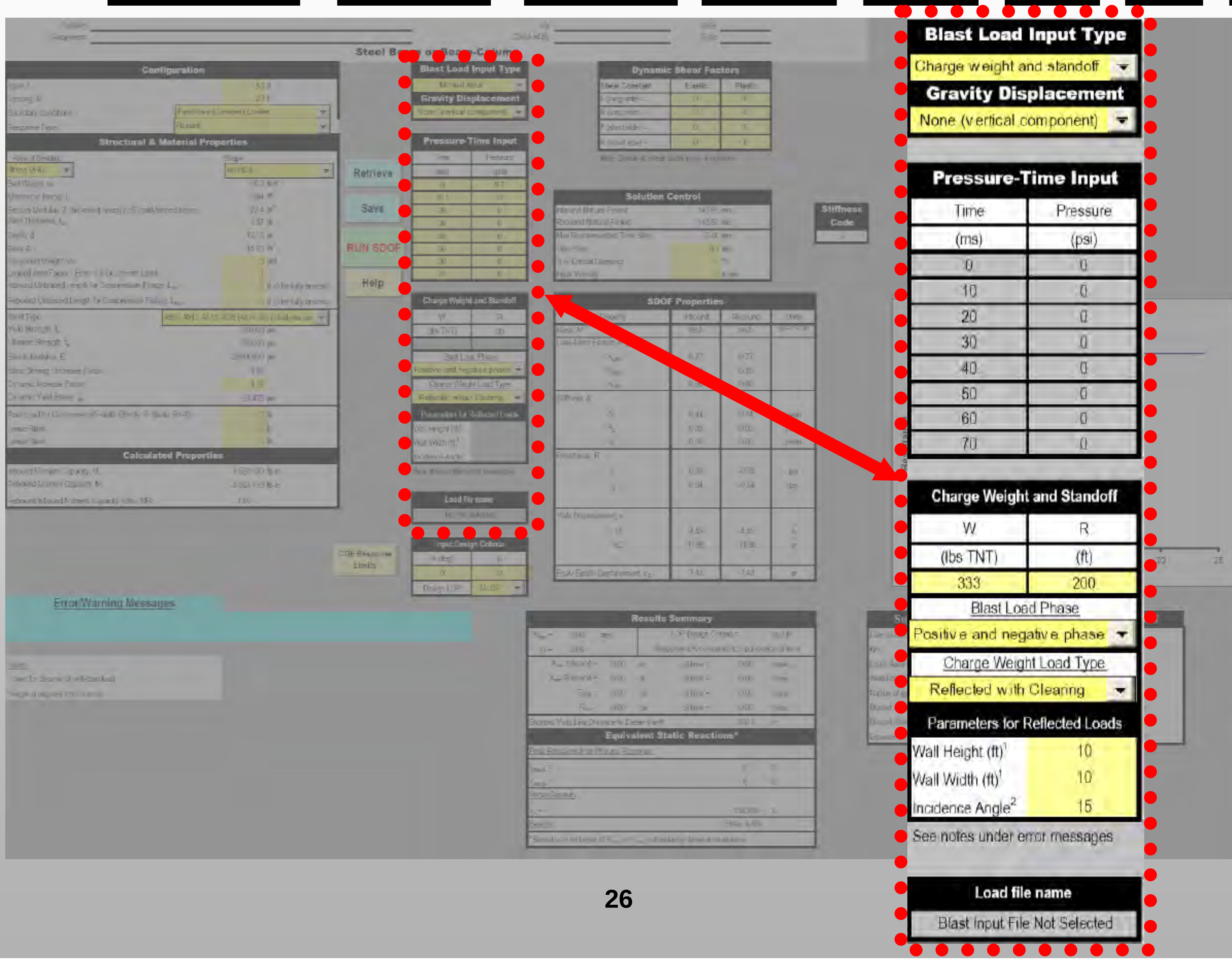
Loading Input



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Loading Options

- Directly input up to 8 time-pressure pairs defining a piecewise linear pressure history
- User inputs charge weight and standoff distance
  - Pressure history for hemispherical surface burst is calculated based on Kingery-Bulmash parameters
  - Side-on or reflected load
    - angle of incidence can be specified for reflected loads
  - With or without negative phase
  - With or without clearing effects
- User designated file with up to 2,000 time-pressure pairs
  - One time-pressure pair separated by commas per line
  - Consistent with DPLOT file saved using the ASCII file option
- Member orientation

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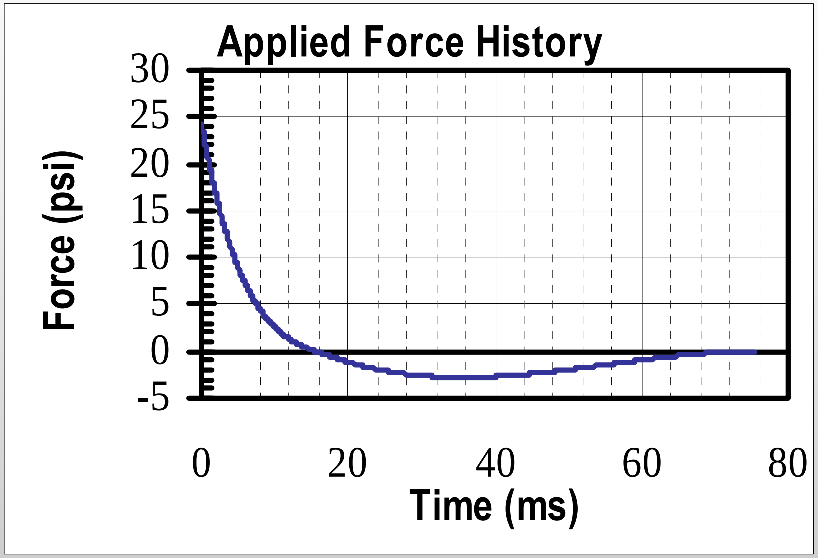
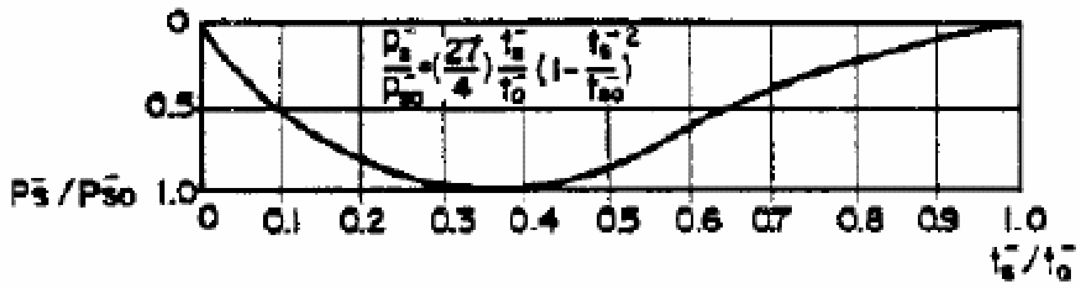
SBEDS Generated Loading

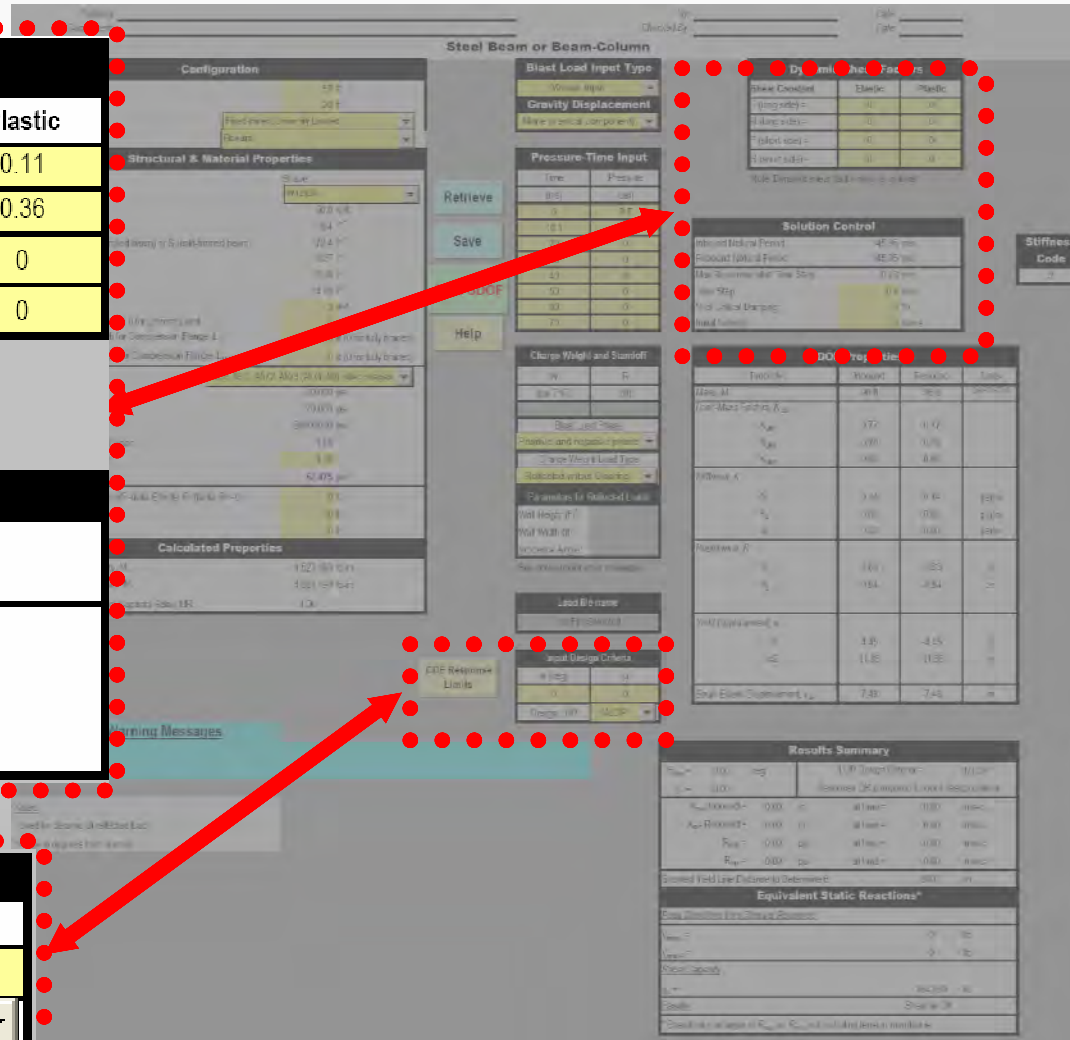
- **Exponential decay in positive phase pressure-history using curve-fit to decay constant from CONWEP**
- **Curve-fit to negative phase using method from Navy document "Blast Resistant Structures, Design Manual 2.08, December 1986" (see below)**





P^-_{so} = peak negative pressure
t^-_{so} = 2*i/ P^-_{so}
i = negative phase impulse
Note: Used for reflected and side-on blast loads

Solution Options



Dynamic Shear Factors		
Shear Constant	Elastic	Plastic
F (long side) =	0.14	0.11
R (long side) =	0.36	0.36
F (short side) =	0	0
R (short side) =	0	0

Note: Dynamic shear factor input is optional

Solution Control		
Inbound Natural Period:	145.95	ms
Rebound Natural Period:	145.95	ms
Max Recommended Time Step:	0.40	ms
Time Step:	0.2	ms
% of Critical Damping:	0	%
Initial Velocity:	0	in/ms

COE Response Limits

Input Design Criteria	
θ (deg)	μ
2	5
Design LOP	MLOP

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Solution Options (continued)

- **Response limits/level of protection desired (optional)**
  - **Does not effect calculations, bookkeeping aid**
- **Dynamic shear constants (optional)**
- **Damping**
  - **0.05% of critical used by default, greater values can be input**
- **Initial velocity**
- **Time step (recommended value provided)**

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Recommended Time Step – Smallest Value Based On:

- **10% of the natural period**
- **10% of the smallest time increment in a manually input blast load**
- **3% of the equivalent triangular positive phase duration or 1.5% of the equivalent triangular negative phase duration of an input charge weight-standoff blast load**
- **3% of the smallest calculated time between local maxima and minima points of a input blast load file**
- **The total 2900 time steps in the time-stepping SDOF method in SBEDS divided by 8 natural periods (but not less than 0.01 ms)**

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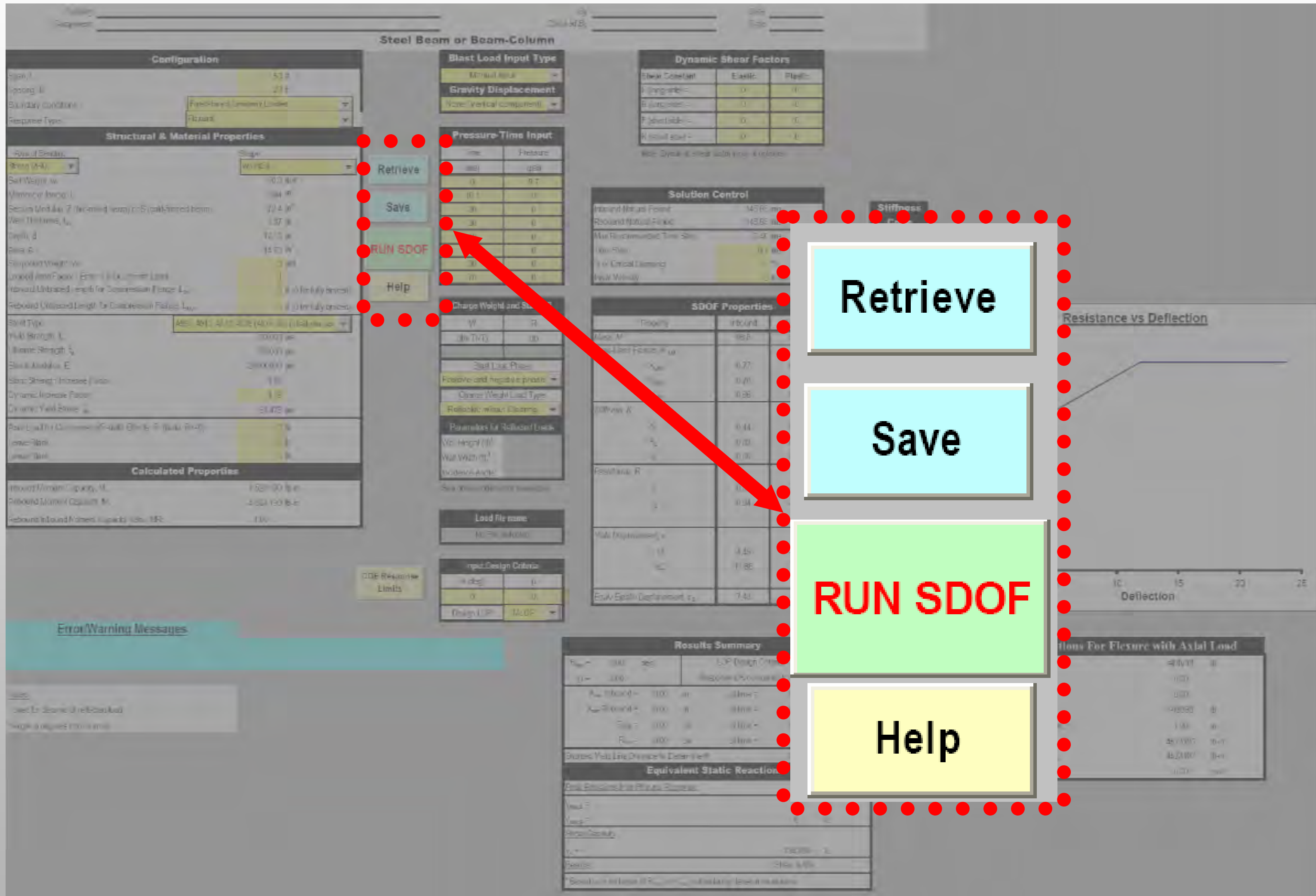
General Commands



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SDOF Solver in SBEDS

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- Constant velocity integration method used to numerically solve SDOF equation of motion at each time step
  - Very stable solutions if small enough time step used
- 2900 time steps in program so very small time steps are usually recommended (less than 1 ms)

Validation

- **Generally within 1%-2% when checked against the SOLVER and WAC codes for numerous cases (27) with multiple yield and stiffness combinations**
- **Constant velocity method has also been validated against finite element calculations performed by BakerRisk**

Analysis Description	Response Range	SDOF Model: Maximum Displacement (in)	SDOF Model: Time of Max. Displacement (msec)	ADINA Model: Maximum Displacement (in)	ADINA Model: Time of Max. Displacement (msec)	Percent Difference
Rectangular Beam	μ=3	5.507	35	5.232	33	**5.0**
	μ=10	17.17	51	15.19	47	**11.5**
	μ=20	33.73	65	28.58	58	**15.3**
	μ=20	26.11 **SDOF based on Z**	55	28.58	58	**-9.5**
I-Shaped Beam (W8x24)	Elastic	2.297	23	2.250	24	**2.0**
	μ=2	5.962	29	5.853	29	**1.8**
	μ=10	29.81	51	26.26	47	**11.9**
	μ=20	59.55	66	49.98	58	**16.1**

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SBEDS Output

- **Maximum deflection and resistance in inbound/outbound response**
  - **Maximum support rotation, ductility ratio, strain rate(s), and equivalent static and dynamic shears**
- **Response history plots for deflection, resistance, equivalent P-Δ load, and dynamic shear and resistance-deflection plot**

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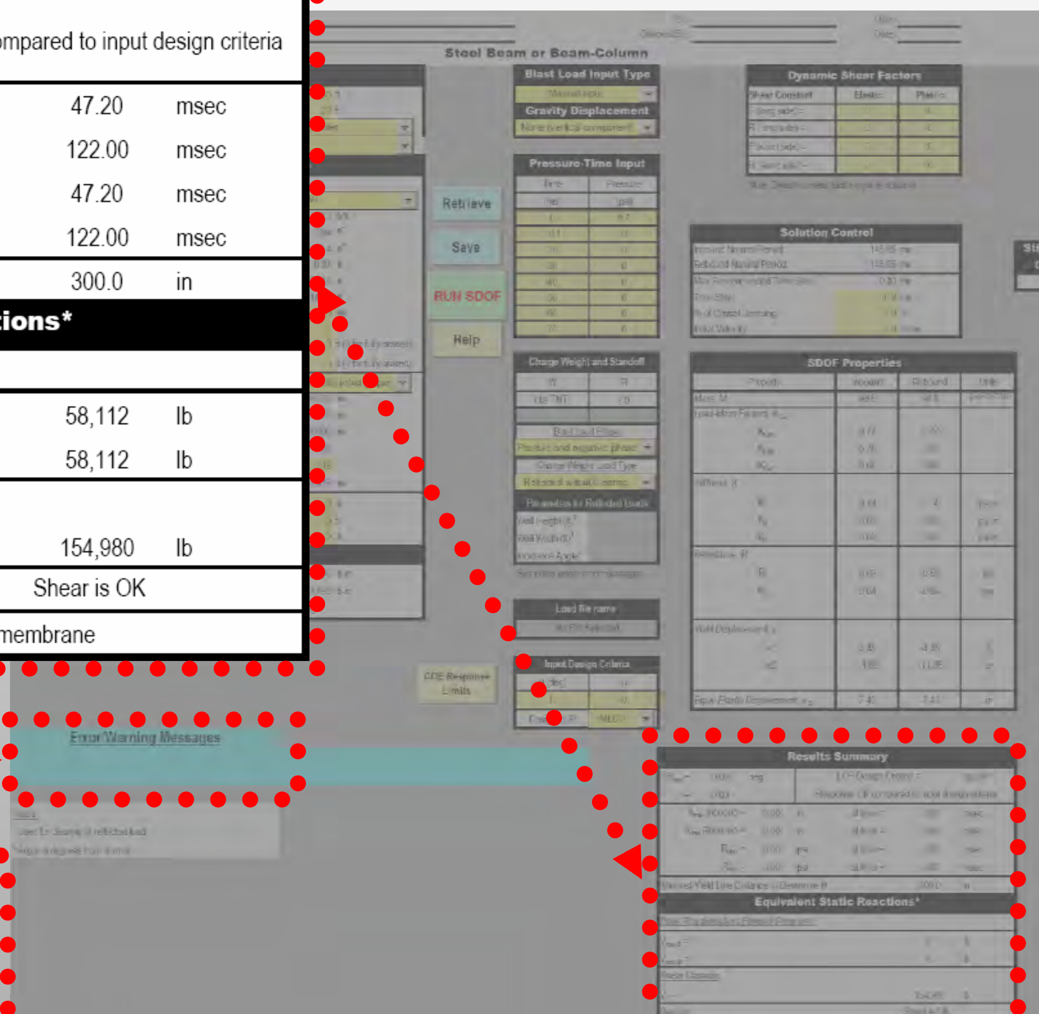
SBEDS Results Summary



Results Summary

θ_{max} =	2.06	deg.	LOP Design Criteria =		MLOP
μ =	1.45		Response NOT OK compared to input design criteria		
X_{max} Inbound =	10.80	in	at time =	47.20	msec
X_{min} Rebound =	-5.05	in	at time =	122.00	msec
R_{max} =	0.81	psi	at time =	47.20	msec
R_{min} =	-0.79	psi	at time =	122.00	msec
Shortest Yield Line Distance to Determine θ:				300.0	in

Equivalent Static Reactions*

Peak Reactions from Flexural Response		
$V_{max,L}$ =	58,112	lb
$V_{max,R}$ =	58,112	lb
Shear Capacity		
V_s =	154,980	lb
Results:	Shear is OK	

* Based only on larger of R_{max} or R_{min}, not including tension membrane

Error/Warning Messages

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SBEDS Detailed Output (Results Sheet)

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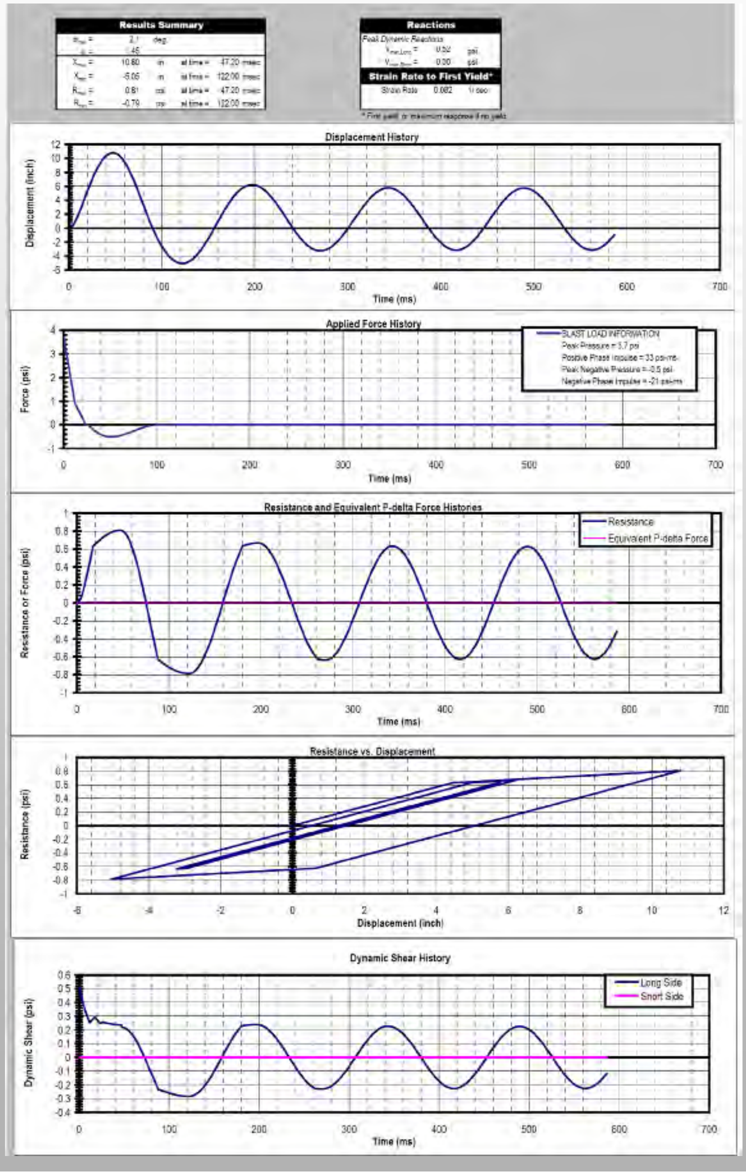

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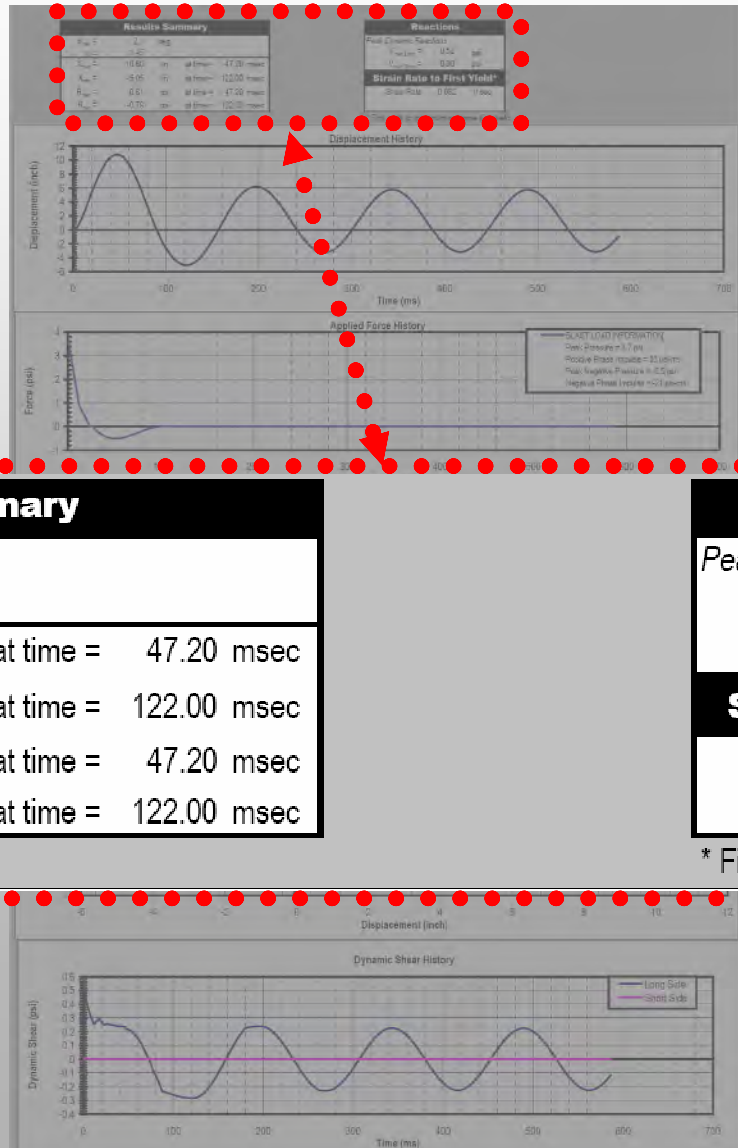
Peaks



Results Summary					
θ_{max} =	2.1	deg.			
μ =	1.45				
X_{max} =	10.80	in	at time =	47.20	msec
X_{min} =	-5.05	in	at time =	122.00	msec
R_{max} =	0.81	psi	at time =	47.20	msec
R_{min} =	-0.79	psi	at time =	122.00	msec

Reactions		
Peak Dynamic Reactions		
$V_{max,Long}$ =	0.52	psi
$V_{max,Short}$ =	0.00	psi
Strain Rate to First Yield*		
Strain Rate	0.082	1/ sec

* First yield, or maximum response if no yield

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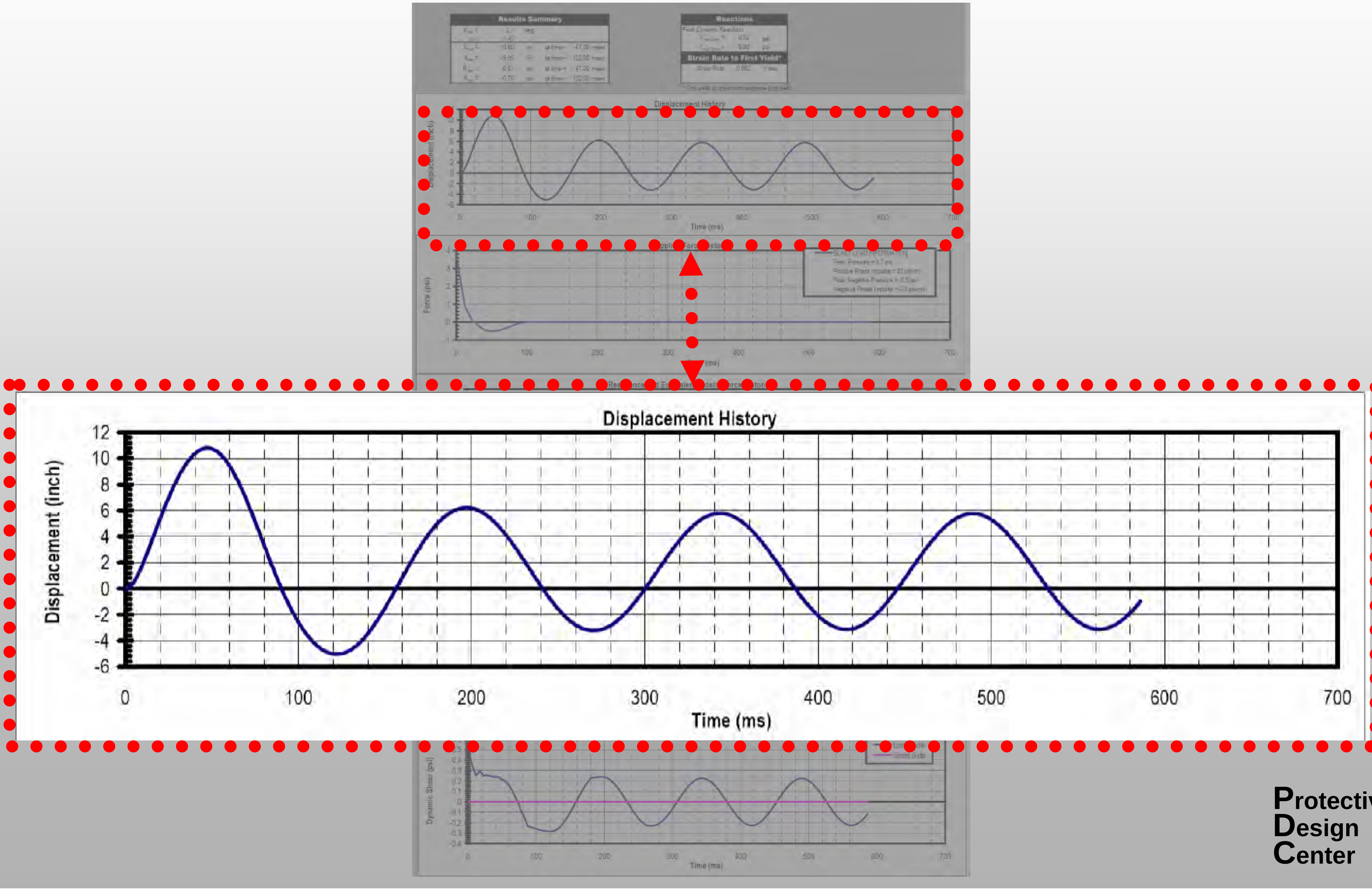
Displacement History



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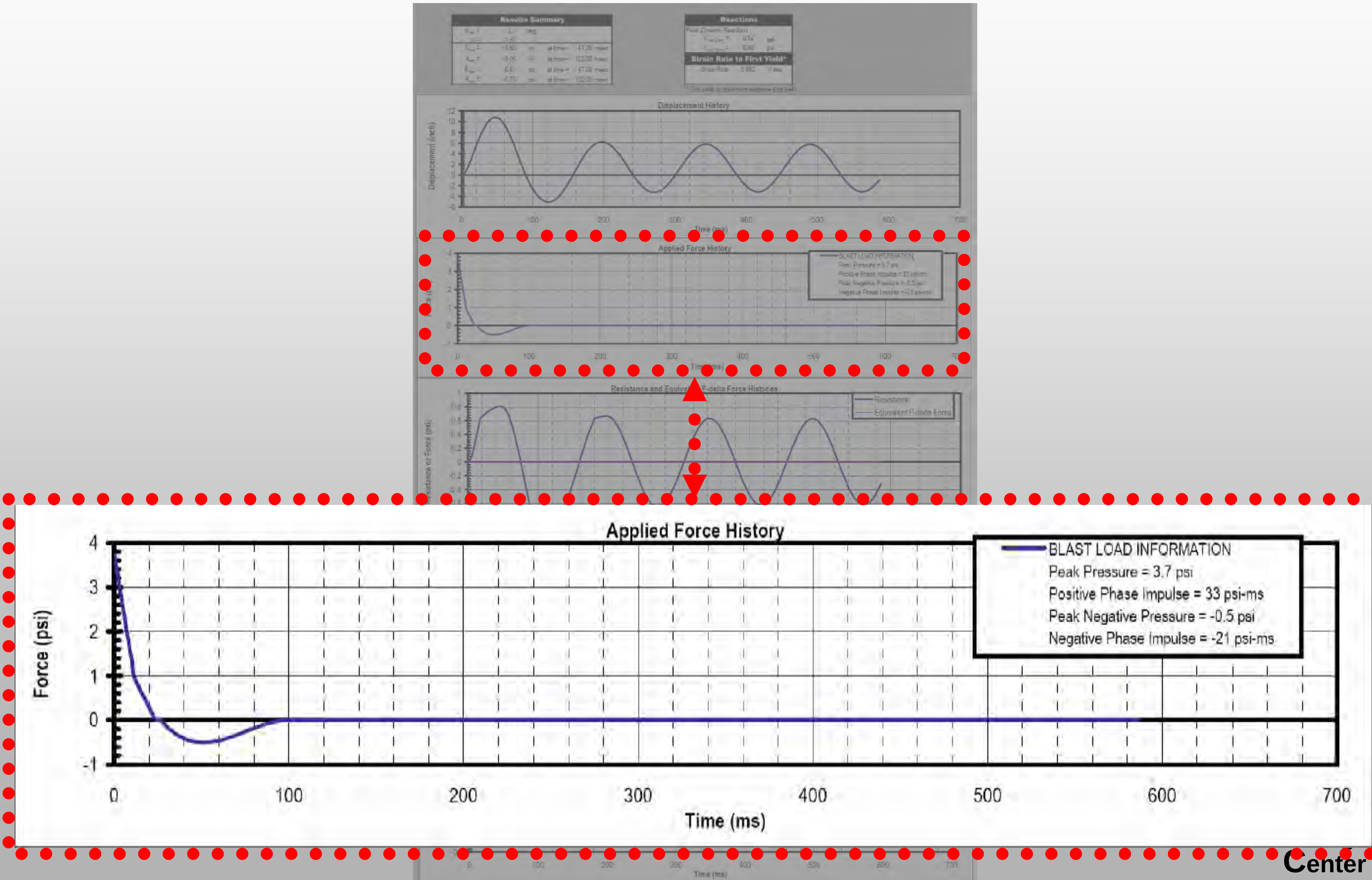
Applied Force History



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Resistance and Equivalent P-Δ Force History

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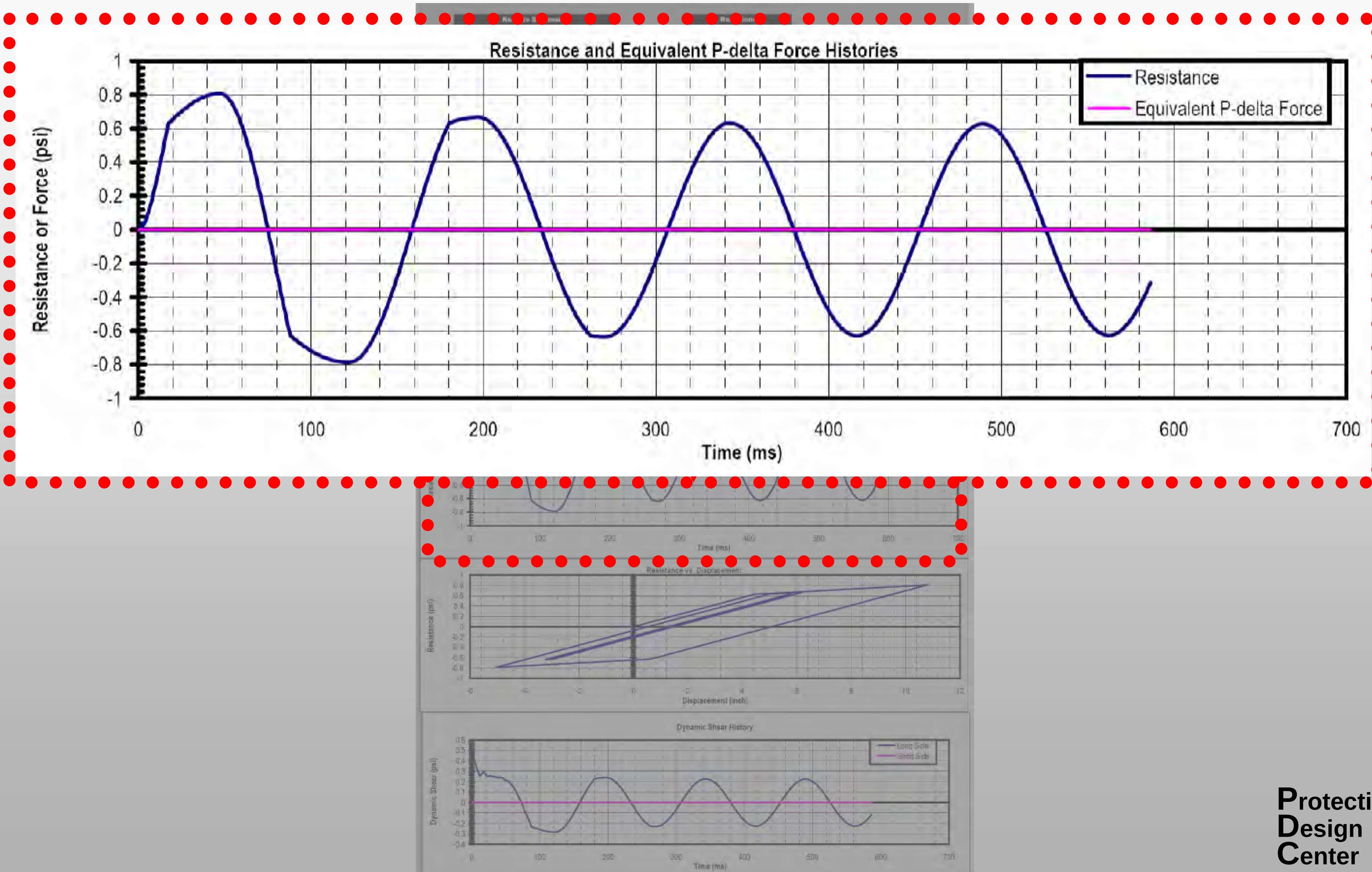

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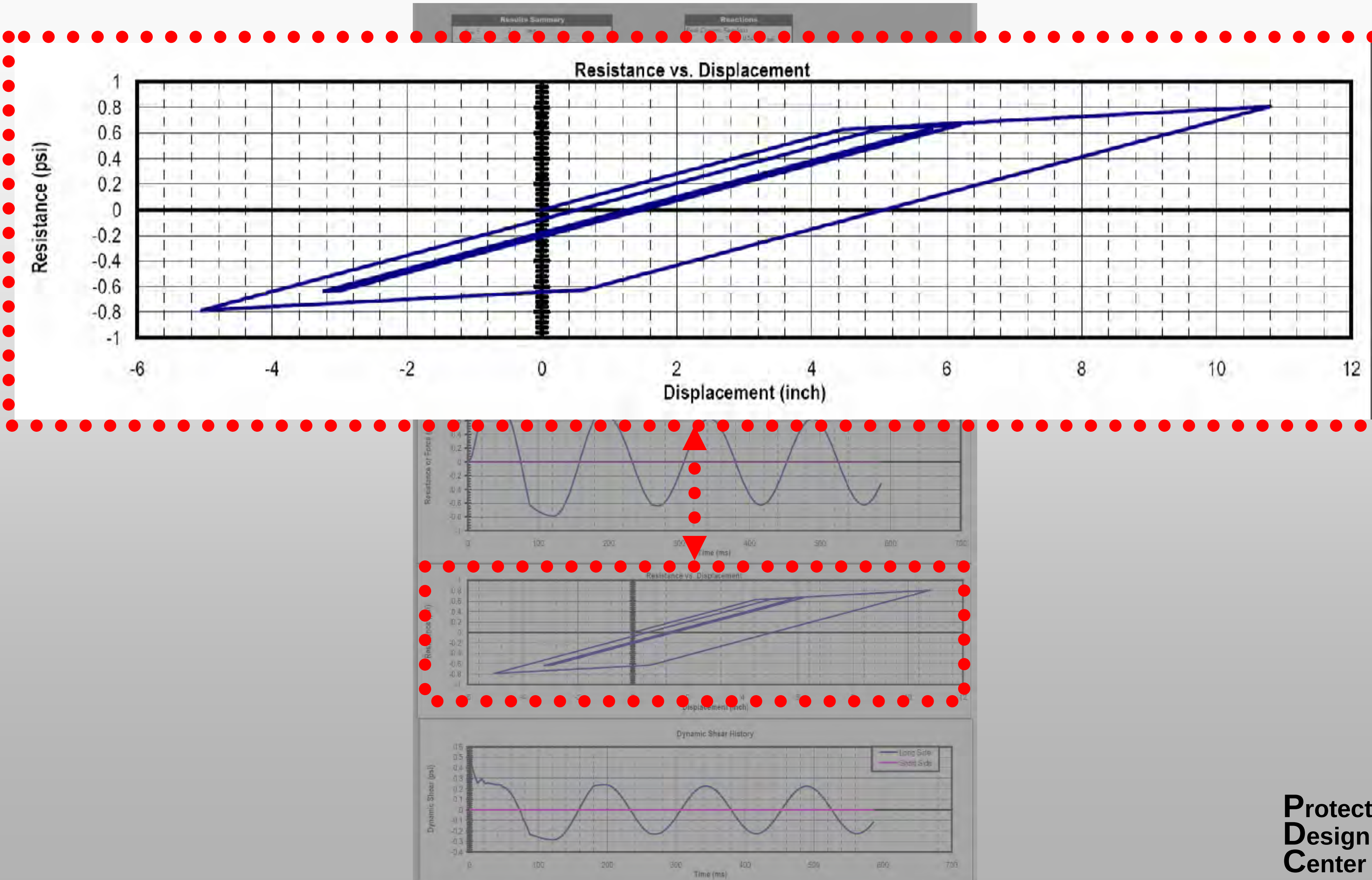
Resistance – Displacement Function



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Dynamic Shear History

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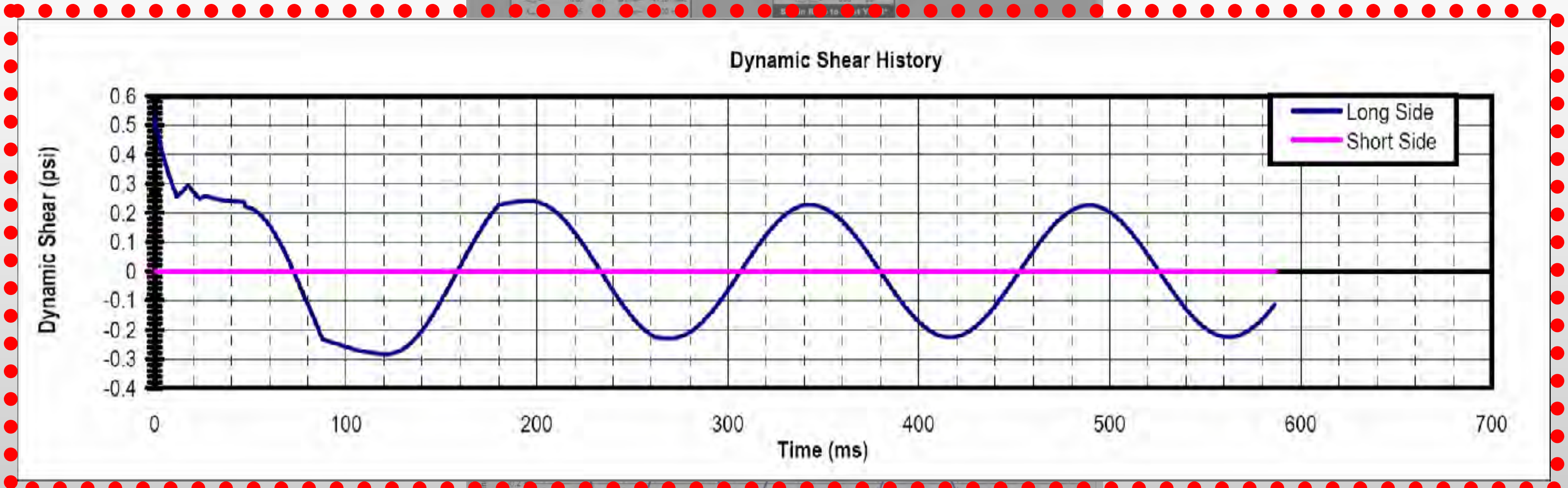

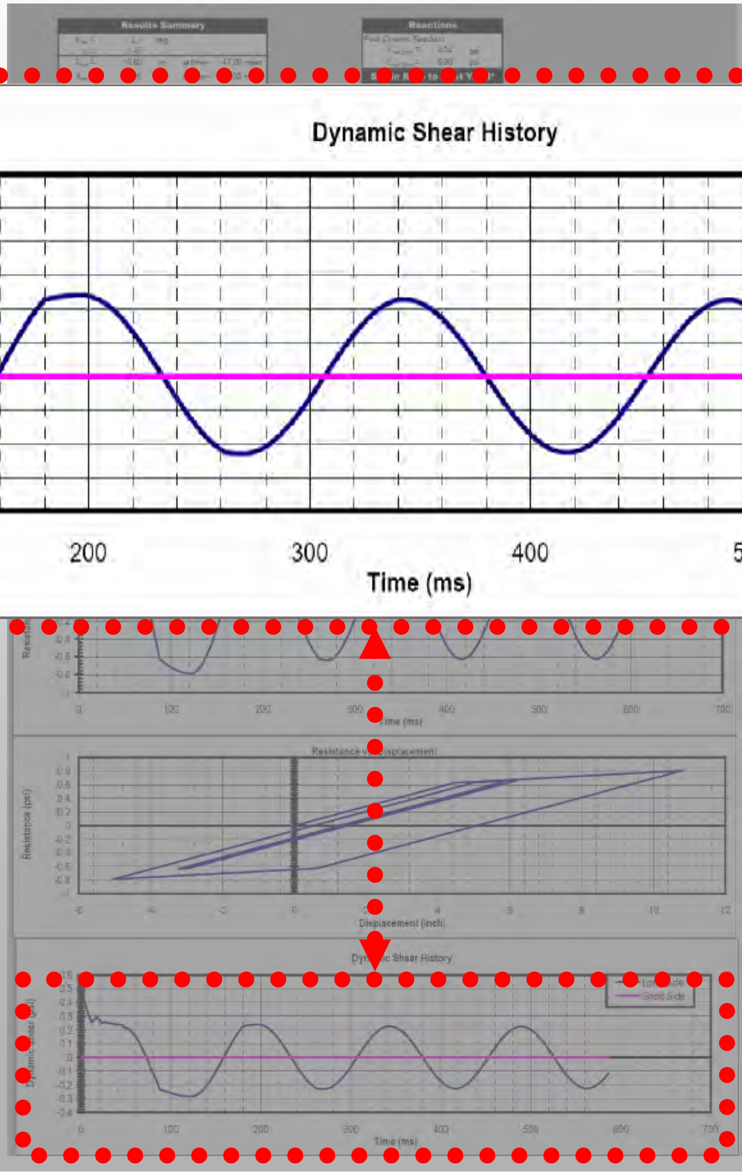

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SDOF Output Sheet

Time (ms)	Applied Force (psi)	Equiv P-delta Force (psi)	Deflection (in)	Velocity (in/ms)	Acceleration (psi/in)	Stiffness (psi/in)	Resistance (psi)
0	3.729287	0	0	3.73E-09	0.048997282	0.14106173	0
0.2	3.681363	0	0.00097995	0.009799	0.048365391	0.14106173	0.00013823
0.4	3.633438	0	0.00389451	0.019409	0.047729923	0.14106173	0.00054937
0.6	3.585514	0	0.00871827	0.028892	0.047090922	0.14106173	0.00122981
0.8	3.53759	0	0.01542566	0.038246	0.046448435	0.14106173	0.00217597
1	3.489666	0	0.023991	0.047472	0.045802511	0.14106173	0.00338421
1.2	3.441742	0	0.03438843	0.056567	0.045153197	0.14106173	0.00485089
1.4	3.393817	0	0.04659199	0.065533	0.044500541	0.14106173	0.00657235
1.6	3.345893	0	0.06057557	0.074368	0.043844591	0.14106173	0.0085449
1.8	3.297969	0	0.07631294	0.083071	0.043185397	0.14106173	0.01076484
2	3.250045	0	0.09377772	0.091642	0.042523007	0.14106173	0.01322845
2.2	3.202121	0	0.11294343	0.100081	0.04185747	0.14106173	0.015932
2.4	3.154196	0	0.13378343	0.108386	0.041188836	0.14106173	0.01887172
2.6	3.106272	0	0.15627098	0.116557	0.040517155	0.14106173	0.02204386
2.8	3.058348	0	0.18037923	0.124593	0.039842475	0.14106173	0.02544461
3	3.010424	0	0.20608117	0.132494	0.039164848	0.14106173	0.02907017
3.2	2.9625	0	0.2333497	0.140259	0.038484323	0.14106173	0.03291671
3.4	2.914575	0	0.26215761	0.147888	0.037800951	0.14106173	0.03698041

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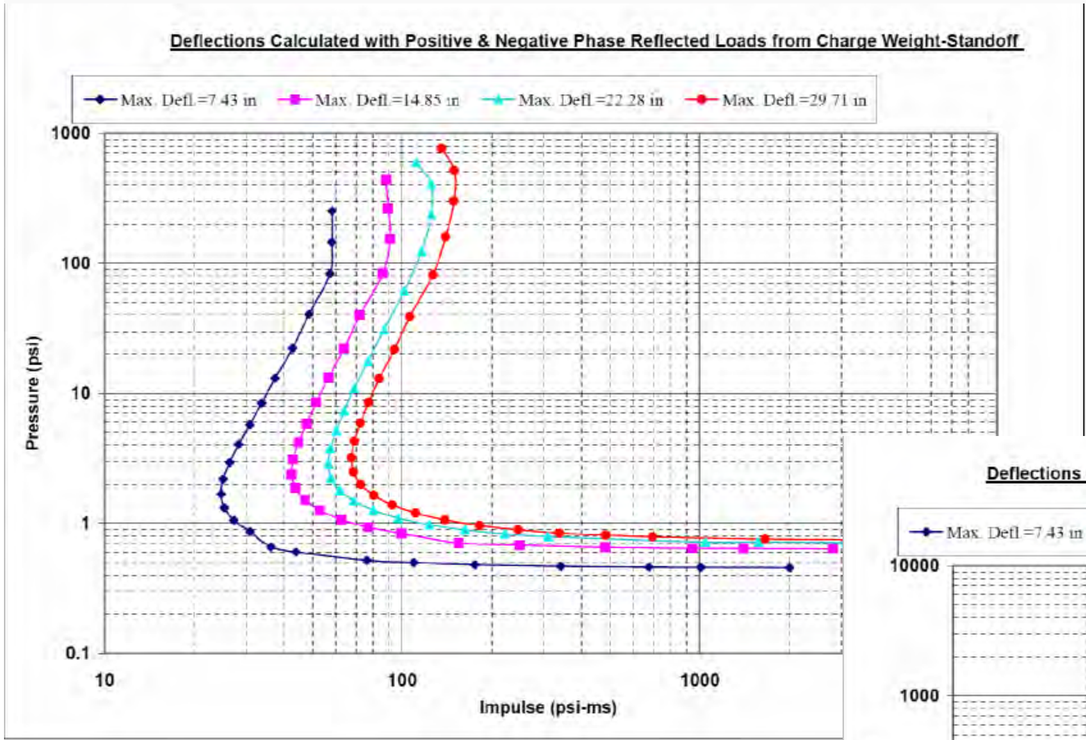
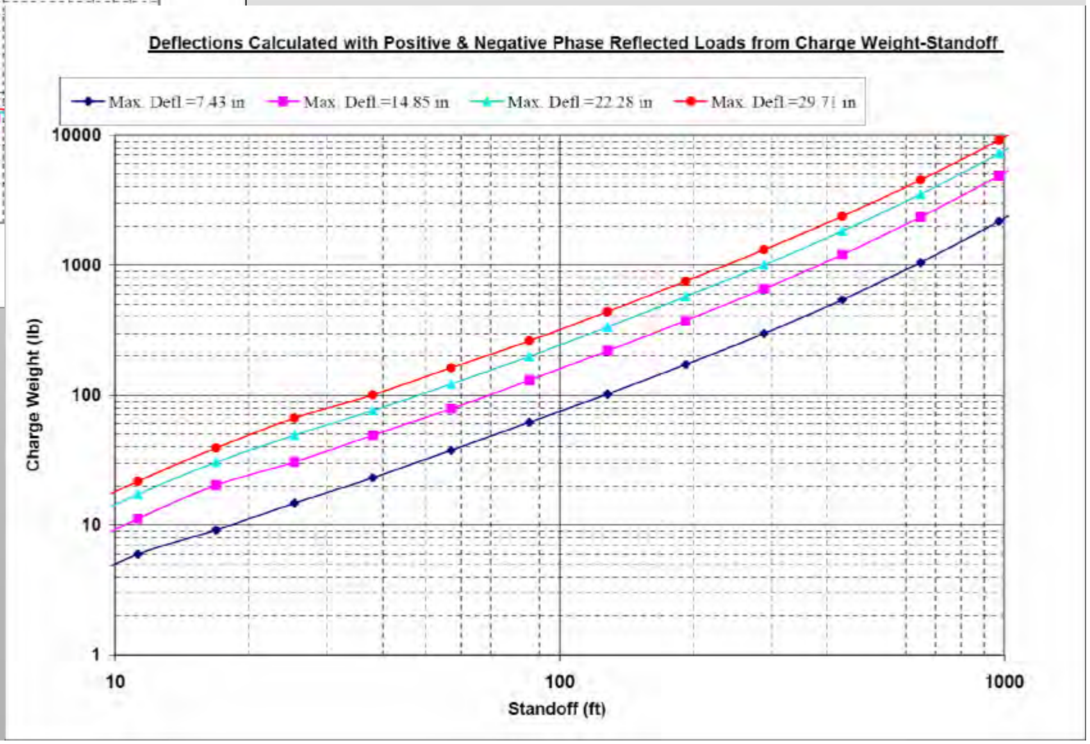
P-i & CW-S Diagrams





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P-i & CW-S Diagrams (cont.)

- User specifies ductility and/or support rotation for up to four levels of response
  - if ductility and support rotation are entered, the one resulting in the smallest deflection is used
- Negative phase is optional
- User selects either P-i, CW-S for side-on loading, or CW-S for fully reflected loading
- Clearing and angle of incidence are not considered
- SBEDS iterates to determine the charge weight and standoff resulting in the specified level of response and then plots either the P-i or CW-S point

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SBEDS Availability

- Distribution Statement A – Approved for public release; distribution is unlimited
- https://pdc.usace.army.mil/
- Registration required (Armadillo protection)
- Limited support available
  - PDC website has FAQ, discussion forum, & issue tracker

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Future

- Methodology manual
- Routine to transfer graphic output to DPLOT
- Additional boundary condition options for 2-way concrete, steel, and masonry slabs and plates
- Cavity wall component (unreinforced masonry)
- Metal stud w/ fascia component
- Account for openings in two-way members

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Summary

- SBEDS is a valuable tool for implementing DoD antiterrorism standards
- Designer friendly tool for conventional construction that combines all steps to design/analyze a wide variety of blast-loaded structural components
- SBEDS calculates single degree of freedom (SDOF) response for 11 types of structural components
  - Also allows for input of general SDOF system
- Based on Army TM 5-1300 &UFC 3-340-01 guidance but draws on other sources for best methodologies
- Approved for public release and available from https://pdc.usace.army.mil/

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CEDAW

(Component Explosive Damage Assessment Workbook)

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Background

- DODI 2000.16 requires vulnerability assessments of installations that include the consideration of explosive threats
- P-i methodology provides a means of rapidly assessing expected damage to structural components
- Many blast assessment tools utilize the P-i methodology in the PDC FACEDAP (1991)
- Recent developments have left FACEDAP 'dated'
  - refined SDOF techniques considering more complex response modes
  - more test data for component response to blast loads
  - better understanding of importance of the negative phase
- These factors accounted for in CEDAW, as well as incorporation of the new DOD definitions for LOP

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CEDAW Methodology

- **P-i relationships developed from scaled relationships specifically for defined DoD levels of protection**
- **Near instantaneous results (not an iterative process as used in SBEDS)**

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CEDAW Components

- One-way corrugated metal panel
- Steel beam or beam-column
- Metal stud wall
- Open-web steel joist
- One-way or two-way reinforced concrete slab
- Reinforced concrete beam
- One-way reinforced masonry
- One-way or two-way unreinforced masonry
- Wood stud wall
- Steel column (assuming connection failure)*
- Reinforced concrete column

CEDAW P-i Output

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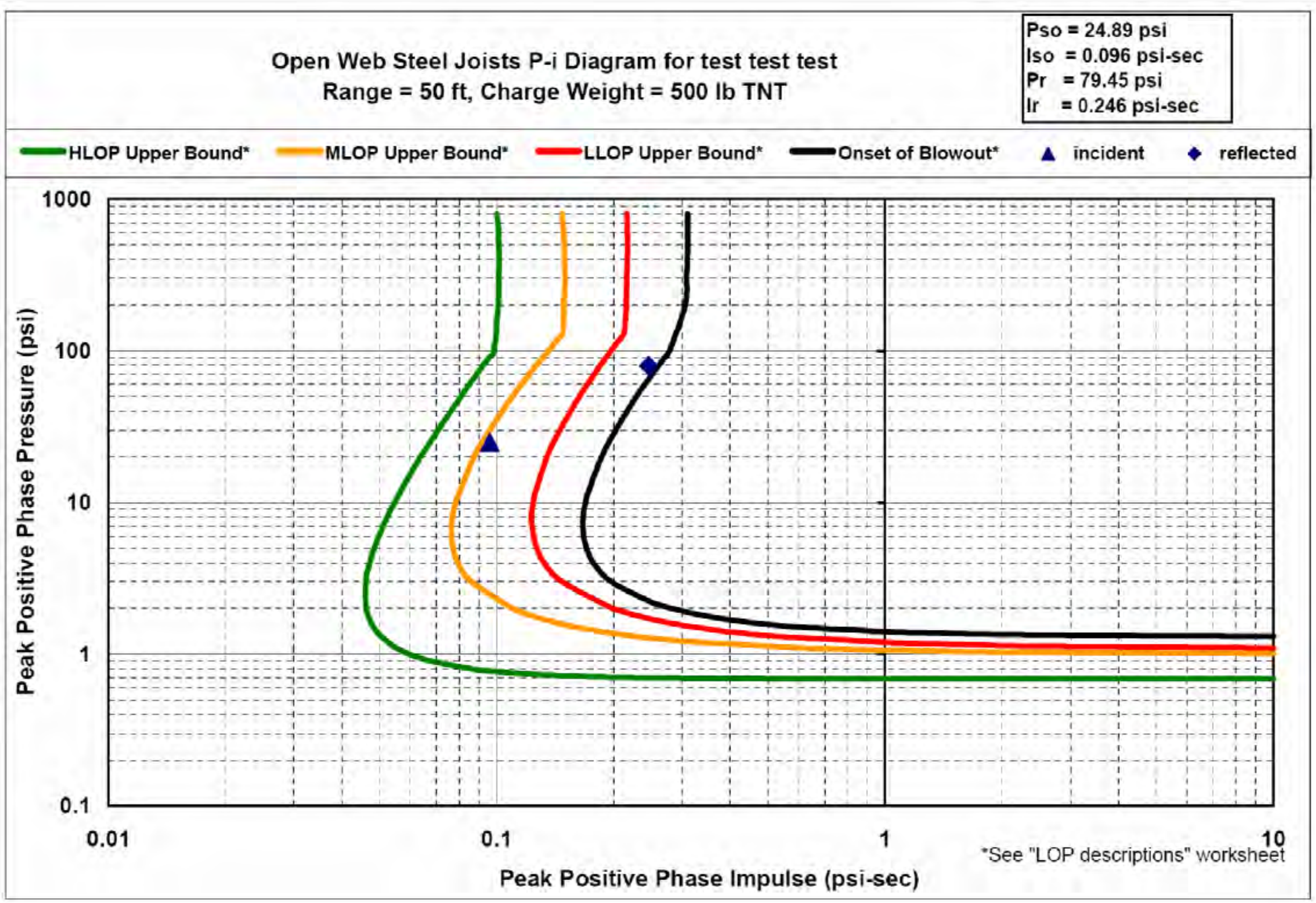

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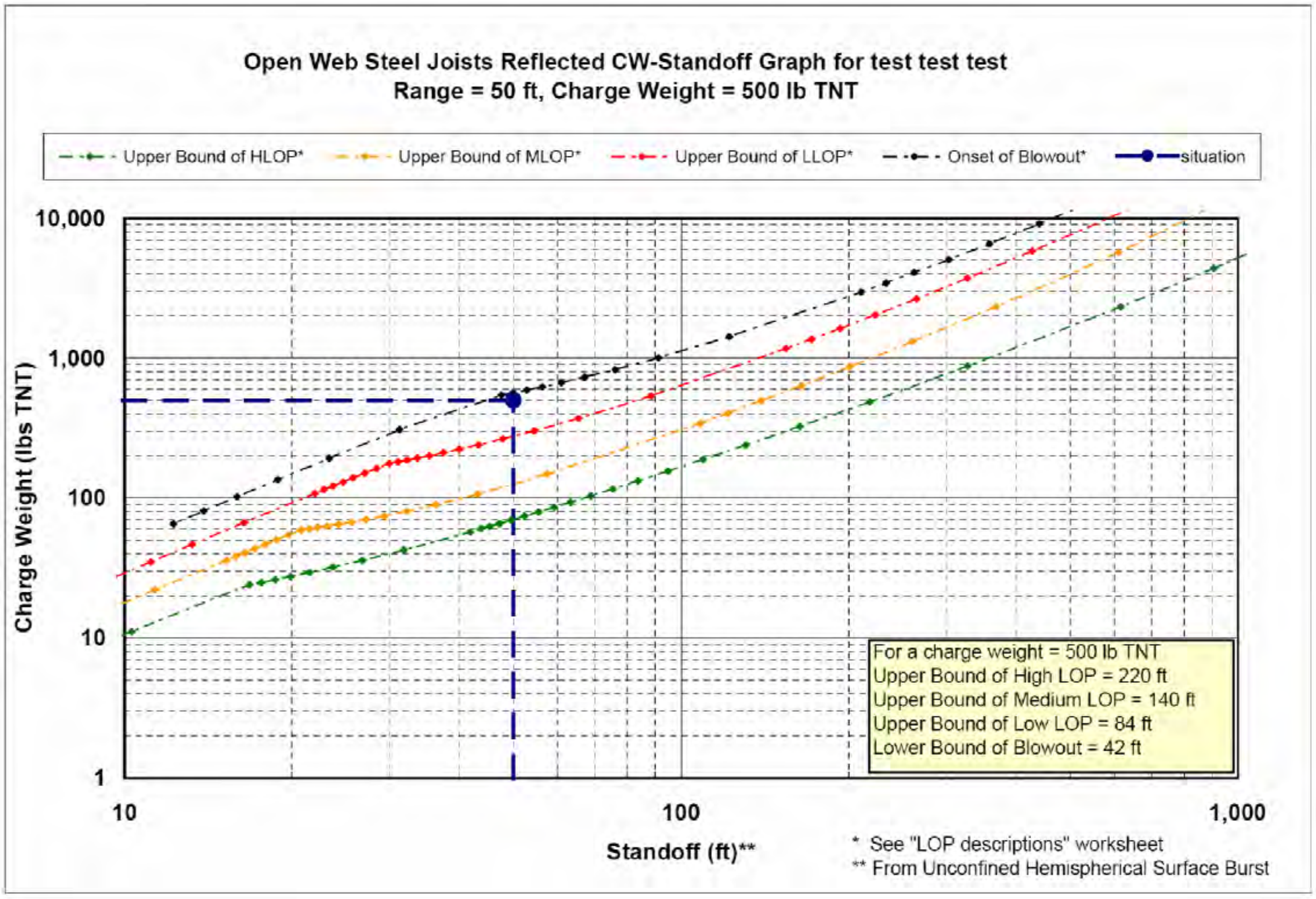
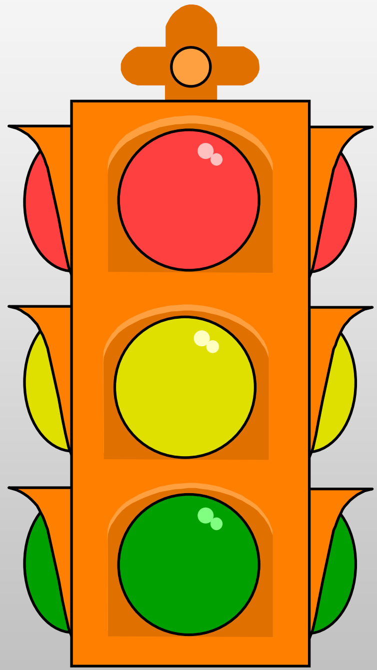
CEDAW CW-S Output



CEDAW Availability

- Distribution Statement A – Approved for public release; distribution is unlimited
- https://pdc.usace.army.mil/
- Registration required (Armadillo protection)
- Limited support available
  - PDC website has FAQ, discussion forum, & issue tracker

Questions



Tri-Service Infrastructure Systems
Conference & Exhibition
August 2 –4, 2005

Design of Buildings to Resist Progressive Collapse UFC 4-023-03

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Acknowledgements

Security Engineering Working Group (SEWG)
(Department of Defense)

Tri- Services
(Army, Navy & Marine Corp, Air Force)

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"Critiques and Trouble Makers"
Bernie Deneke, NAVFAC
Ed Conrath, USACE PDC
Tim Campbell, USACE PDC

Overview

- Motivated in part by recent terrorist attacks, the Department of Defense now requires explicit consideration of Progressive Collapse (PC) in the design of new buildings and retrofit of existing buildings.
- Previously, there were no US design codes that provided PC design procedures that met DoD's needs.

Overview

- The Security Engineering Working Group, through the Naval Facilities Command (NAVFAC), contracted with ARA to develop Unified Facilities Criteria 4-023-03 "Design of Buildings to Resist Progressive Collapse."
- The UFC has been approved by the three services (Navy, Army, and Air Force) and will be officially signed in the near future.

Background

- Definition of Progressive Collapse:
  - The commentary in the American Society of Civil Engineers (ASCE) Standard 7-02 “Minimum Design Loads for Buildings and Other Structures” describes progressive collapse as
    - “the spread of an initial local failure from element to element, eventually resulting in the collapse of an entire structure or a disproportionately large part of it.”

Background

- In the United States and other Western nations, progressive collapse is a relatively rare event; to occur, it requires:
  - an abnormal loading to initiate the damage

  AND

  - a structure that lacks adequate continuity, ductility, and redundancy.
- However, significant casualties can result when progressive collapse occurs.

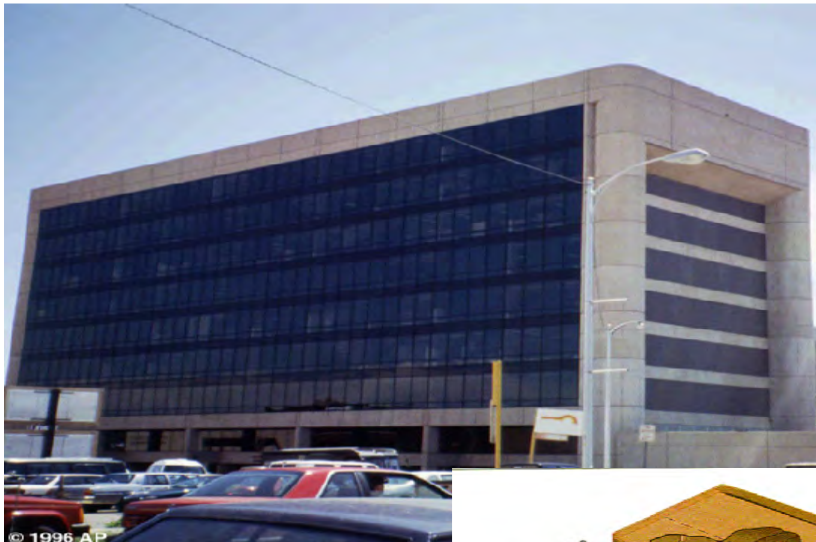
Background

- **Ronan Point Apartment Building – London, England, May 1968**
  - Propane heater exploded on 18th floor of 24 floor building
  - Primary supporting exterior bearing panel blew out
  - Floors above collapsed down
  - Falling debris caused collapse of the lower floors, nearly to the ground
- As a result, the British adopted explicit progressive collapse design measures into their building code.

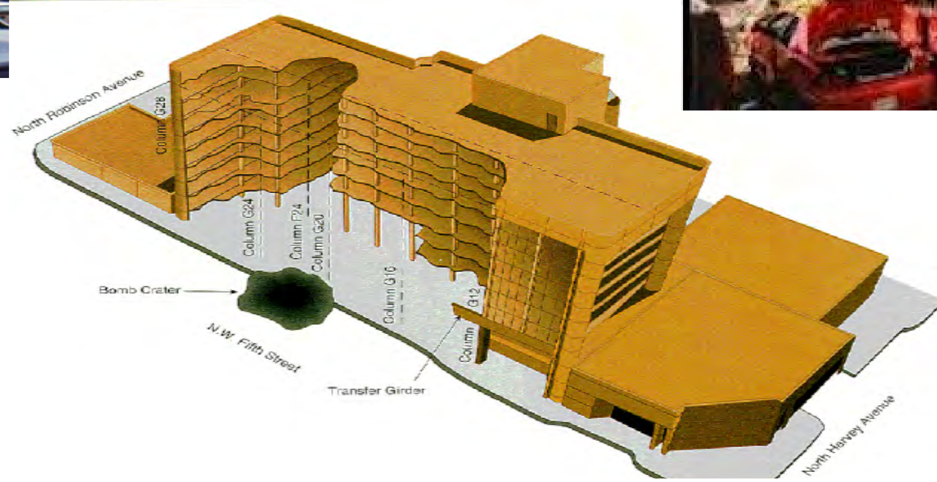
INTERNAL EXPLOSION

Background

A.P. Murrah Federal Building – Oklahoma City, Oklahoma



TERRORIST ATTACK



Background

1983

Exterior of US Embassy building in Dar es Salaam after bombing, 7 August.

u.s. embassy at nairobi, kenya

1998

1995

1996

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Existing Approaches

- America:
  - ASCE and material specific codes (ACI, AISC, TMS, etc) do not provide explicit and enforceable requirements for progressive collapse.
- UK
  - Explicit requirements in RC, steel, and masonry codes.
  - Overall approach is composed of three methods:
    - Tie Forces (Indirect Design)
    - Alternate Path (Direct Design)
    - Specific Local Resistance (Direct Design)

Existing Approaches

- Proposed British Standards
  - A risk/consequence approach will be used for progressive collapse requirements, to choose structures that require PC design.
- GSA Guidelines
  - Developed by ARA, Vicksburg, for GSA.
  - Alternate Path Method is used exclusively.

Progressive Collapse Design Approach

- UFC 4-023-03, “Design of Buildings to Resist Progressive Collapse”
  - Provides the design guidance necessary to reduce the potential of progressive collapse for new and existing DoD facilities that experience localized structural damage through manmade or natural events.

Progressive Collapse Design Approach

- Applicability
  - Applies to all DoD services and to all DoD inhabited buildings of three or more stories.
  - Applies to new construction, major renovations, and leased buildings and will be utilized in accordance with the applicability requirements of UFC 4-010-01 or as directed by Service Guidance.

Progressive Collapse Design Approach

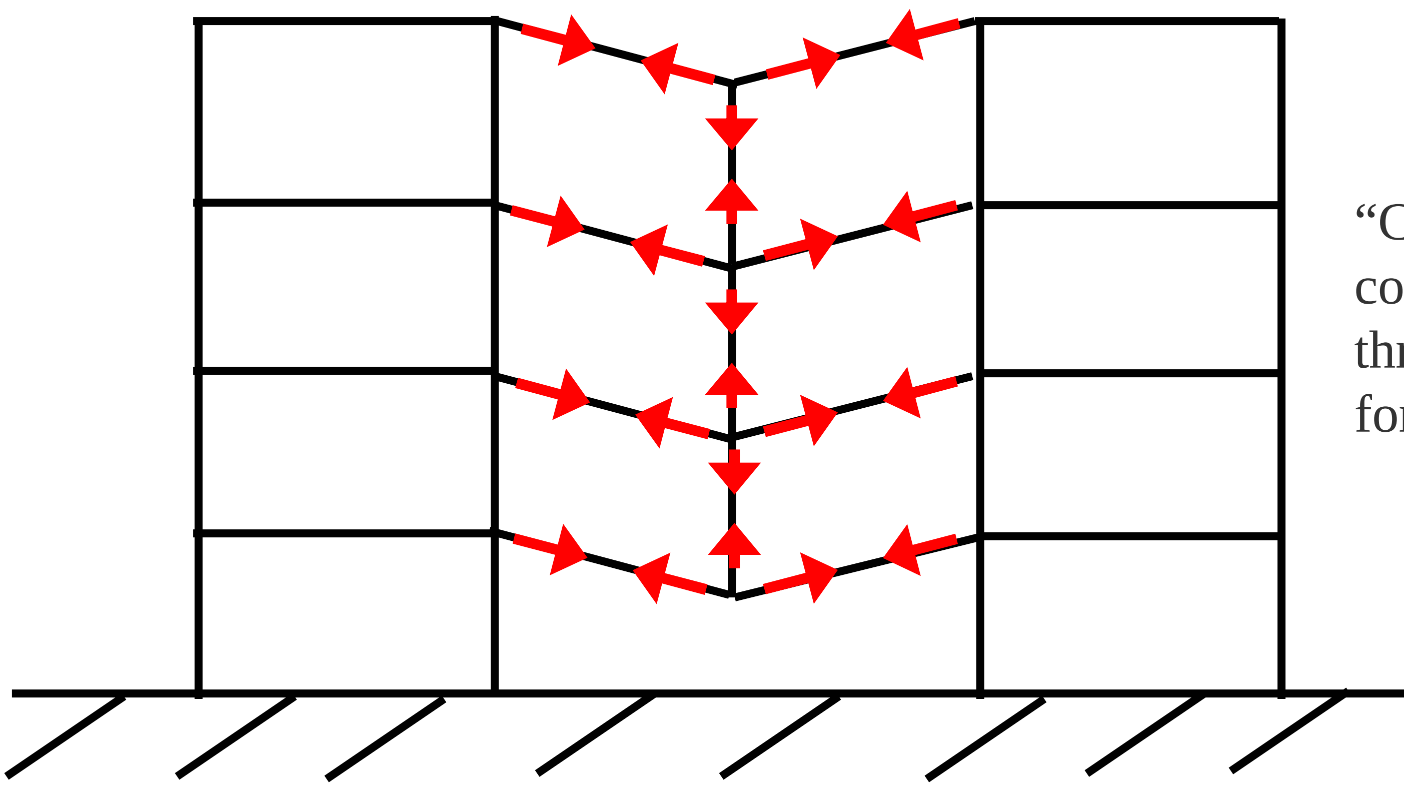
- Five materials are considered:
  1. Reinforced Concrete
  2. Structural Steel
  3. Masonry
  4. Light Frame Wood
  5. Cold-Formed Steel

Progressive Collapse Design Approach

- Design approach employs two main mechanisms:
  - Catenary (Tie Forces, Indirect Design)
  - Flexural (Alternate Path, Direct Design)

Progressive Collapse Design Approach

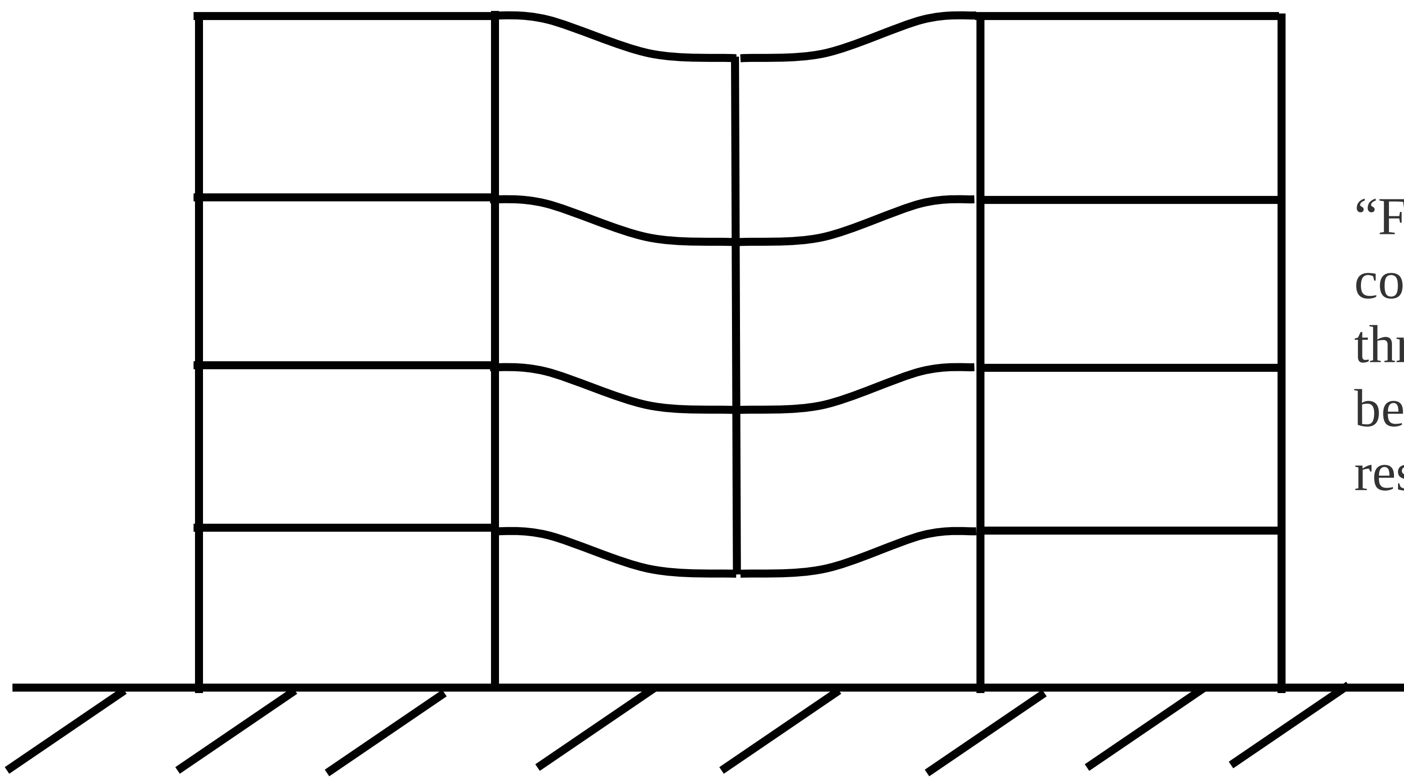
- Indirect Approach, Tie Forces



"Catenary Action"; collapse resisted through tensile forces

Progressive Collapse Design Approach

- Direct Approach, Alternate Path



"Flexural Action"; collapse resisted through bending/membrane response

Progressive Collapse Design Approach

- **The PC UFC is threat-independent and is NOT intended to address the hardening of a building that is exposed to a specific explosive threat.**
- Level of required PC design depends upon required level of protection, which is determined by the Project Planning Team.

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Progressive Collapse Design Approach

Level of Protection and PC Design Requirements for New and Existing Construction

<table>
<tr><th>Level of Protection</th><th>PC Design Requirement</th></tr>
<tr><td>Very Low</td><td>Provide horizontal Tie Forces.</td></tr>
<tr><td>Low</td><td>Provide horizontal and vertical Tie Forces.</td></tr>
<tr><td>Medium</td><td rowspan="2">Satisfy the following three requirements:
A) Provide horizontal and vertical Tie Forces.
B) Apply the Alternate Path method.
C) Meet additional ductility requirements that effectively “harden” the perimeter, ground-floor load-bearing elements</td></tr>
<tr><td>High</td></tr>
</table>

Progressive Collapse Design Approach

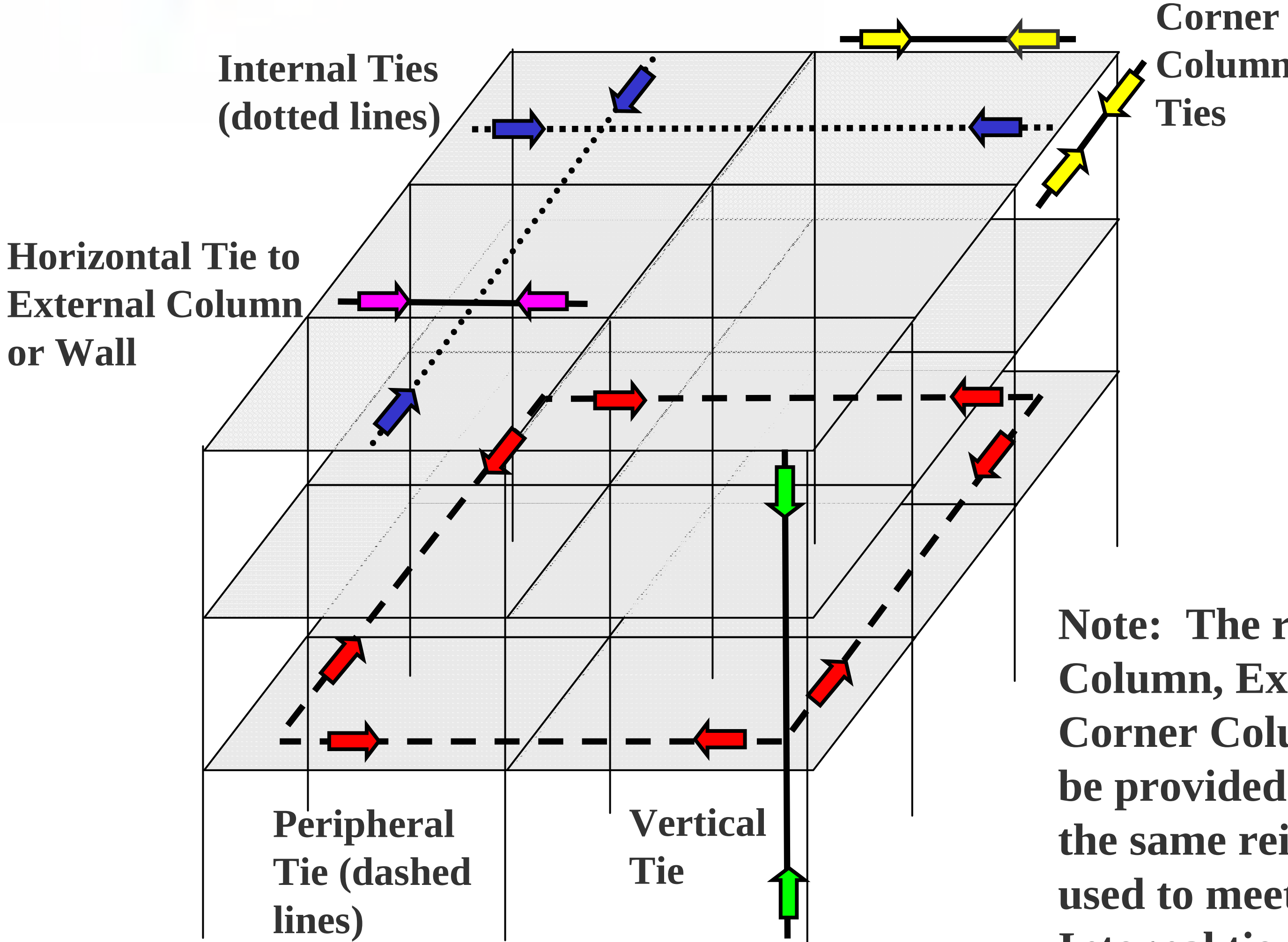
- Levels of Protection are based on asset value.
- Thus, we cannot create a list of "typical structures"; however:
  - All inhabited buildings 3 stories and above will require at least VLLOP
  - All primary gathering buildings and billeting will require at least the LLOP
- Most DoD buildings will be VLLOP or LLOP, i.e., Tie Forces are all that's needed.

Progressive Collapse Design Approach

- LRFD approach is used for both Tie Forces and Alternate Path requirements
  - Consistent with existing material design codes.
  - May allow easier transition to the civilian world.
  - Makes use of the ASCE 7-02, Section C2.5, Load Combinations for Extraordinary Events:

$$(0.9 \text{ or } 1.2)\ D + (0.5\ L \text{ or } 0.2\ S) + 0.2\ W$$

Progressive Collapse Design Approach



Note: The required External Column, External Wall, and Corner Column tie forces may be provided partly or wholly by the same reinforcement that is used to meet the Peripheral or Internal tie requirement.

Progressive Collapse Design Approach

- Tie Forces
  - For example, for steel

    In each direction, internal ties must have a required tensile strength (in kN) equal to the greater of:

$$0.5\ (1.2D + 1.6L)\ s_t\ L_l \qquad \text{but not less than 75 kN}$$

where:

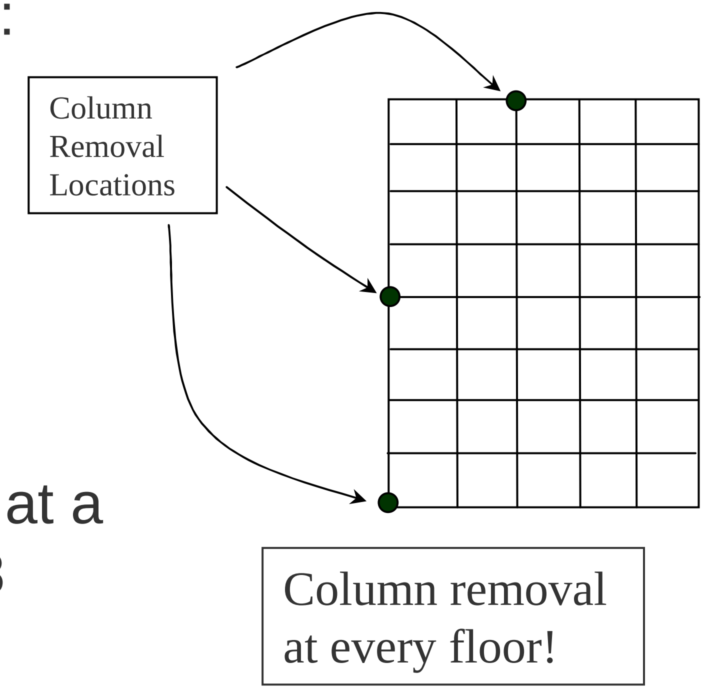
D	=	Dead Load (kN/m^2)
L	=	Live Load (kN/m^2)
L_l	=	Span (m)
s_t	=	Mean transverse spacing of the tie adjacent to the ties being checked (m)

Progressive Collapse Design Approach

- Alternate Path
  - Structure must be able to bridge over a removed element.
  - Not intended to replicate an event, but to ensure a consistent level of resistance.
  - Applied in 2 situations:
    1. An element cannot provide adequate vertical tie force—bridging must be shown.
    2. For MLOP and HLOP.

Progressive Collapse Design Approach

- Alternate Path, cont'd
  - For Alternate Path in MLOP and HLOP structures, these locations of column/wall removal are required:
    - Center of short side
    - Center of long side
    - Corner
    - Significant changes in structural system
  - Columns/walls are removed, one at a time, from EACH floor (i.e., with 8 floors, at least 24 Alternate Path analyses are required).



Progressive Collapse Design Approach

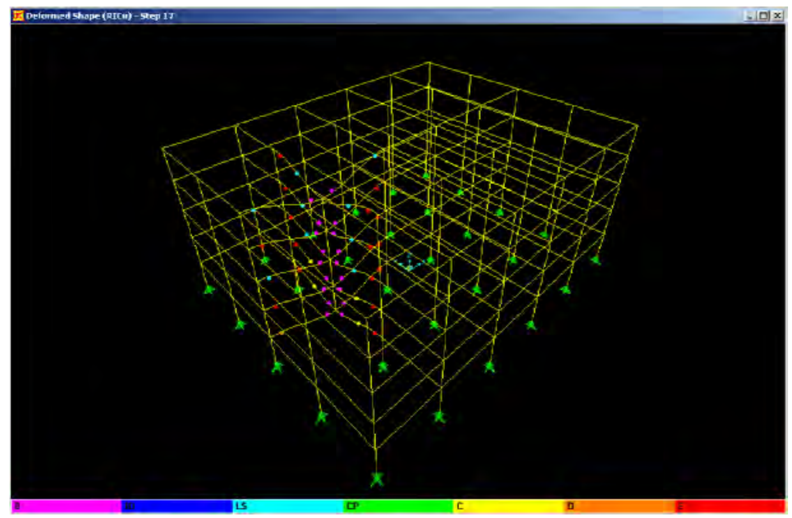
- Alternate Path, cont'd
  - Damage Limits
    - Exterior column or wall removal:
      - Local damaged area of the floor area directly above and directly below the removed element must be less than 70 m^2 (750 ft^2) or 15% of the floor area, whichever is smaller. The damage must not extend beyond the bays associated with the removed wall or column.
    - Interior column or wall removal:
      - Similar, but 140 m^2 (1500 ft^2) or 15% of the floor area, whichever is smaller.

Progressive Collapse Design Approach

- Common Design Requirements For All Construction Types
  - Increased Effective Column and Wall Height
  - Upward Loads on Floors and Slabs

Progressive Collapse Design Approach

- PC UFC contains appendices with worked examples of:
  - 5-story reinforced concrete structure.
  - 5-story steel structure
  - 3-story wood barracks



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Summary

- The DOD UFC 4-023-03 bases the level of required progressive collapse design on the facility's required level of protection.
- Overall approach is similar to British requirements.
- Most DOD structures will be rated at Very Low or Low Level of Protection and only Tie Forces will be required; this should not be an odious demand.
- The UFC is a living document and can/will be modified in the future as engineers, designers, and facility owners provide feedback on the cost and impact on their structures.

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Questions

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FATIGUE AND FRACTURE ASSESSMENT

JESSE STUART HIGHWAY BRIDGE

HUNTINGTON DISTRICT

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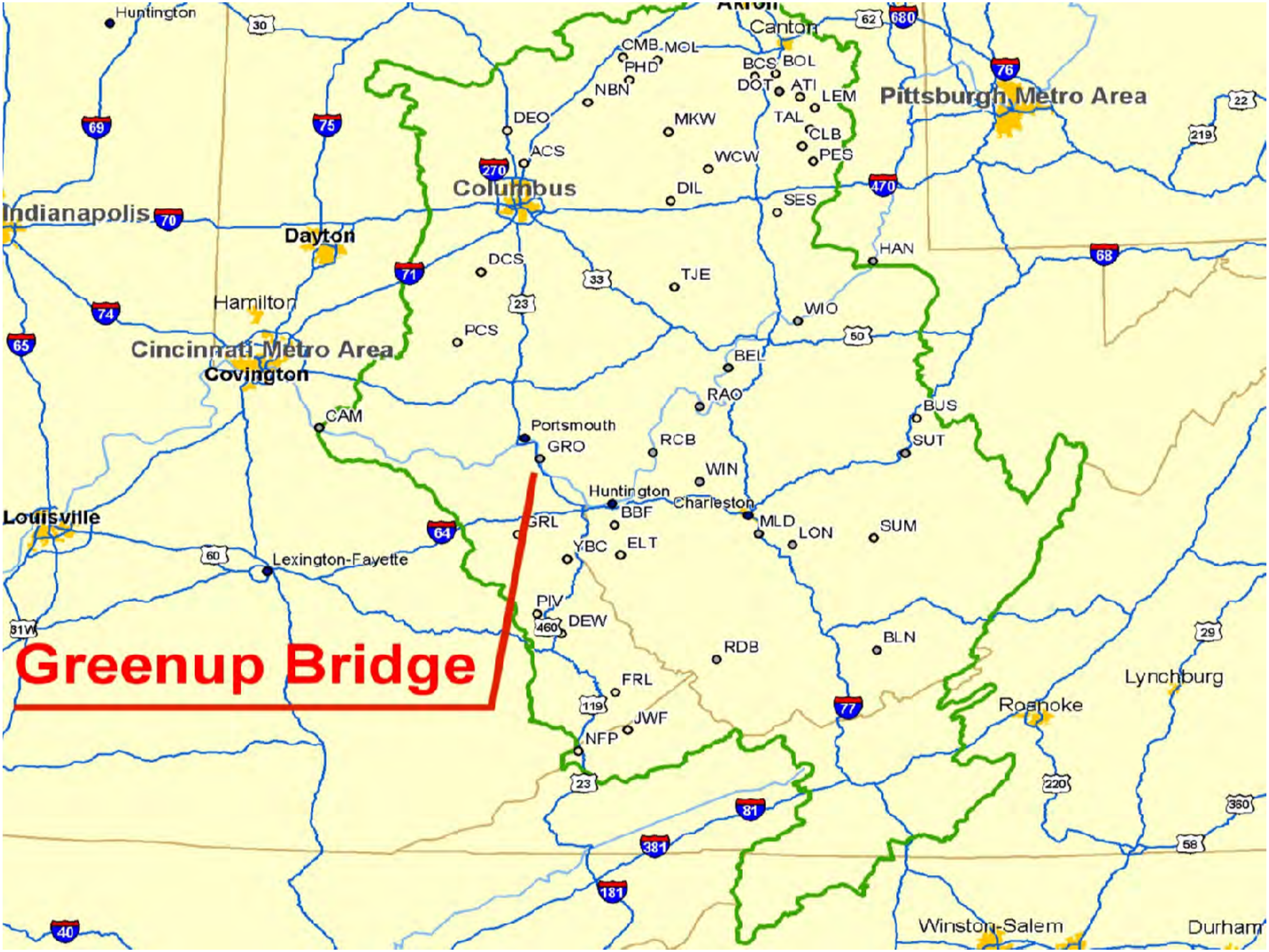
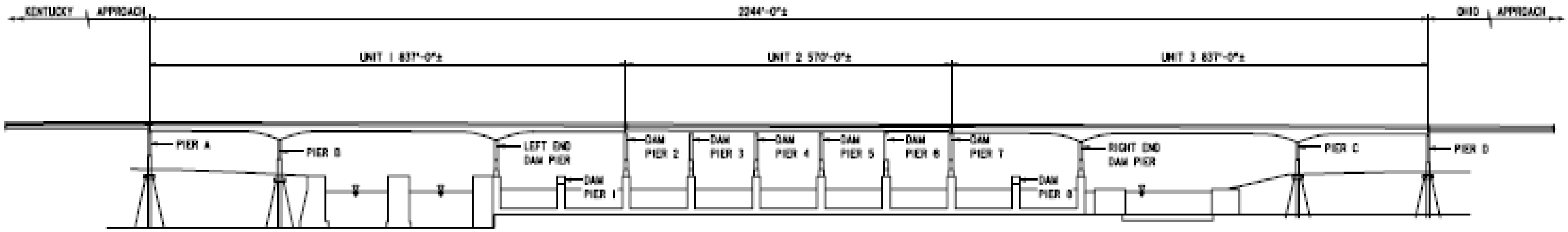

Greenup Bridge
Huntington
Canton
Pittsburgh Metro Area
Columbus
Indianapolis
Dayton
Hamilton
Cincinnati Metro Area
Covington
Portsmouth
Huntington
Charleston
Louisville
Lexington-Fayette
Lynchburg
Roanoke
Winston-Salem
Durham
CMB
MOL
PHD
NBN
BCS
BOL
DOT
ATI
LEM
TAL
CLB
PES
MKW
DEO
ACS
WCW
DIL
SES
HAN
DCS
TJE
WIO
PCS
BEL
RAO
CAM
BUS
SUT
GRO
RCB
WIN
BBF
MLD
LON
SUM
GRL
YBC
ELT
PIV
DEW
RDB
BLN
FRL
JWF
NFP

View of Jesse Stuart Highway Bridge looking north (downstream) from Kentucky side of the Ohio River.

JESSE STUART HIGHWAY BRIDGE
GREENUP LOCKS AND DAM   OHIO RIVER
SEPTEMBER 9, 2003

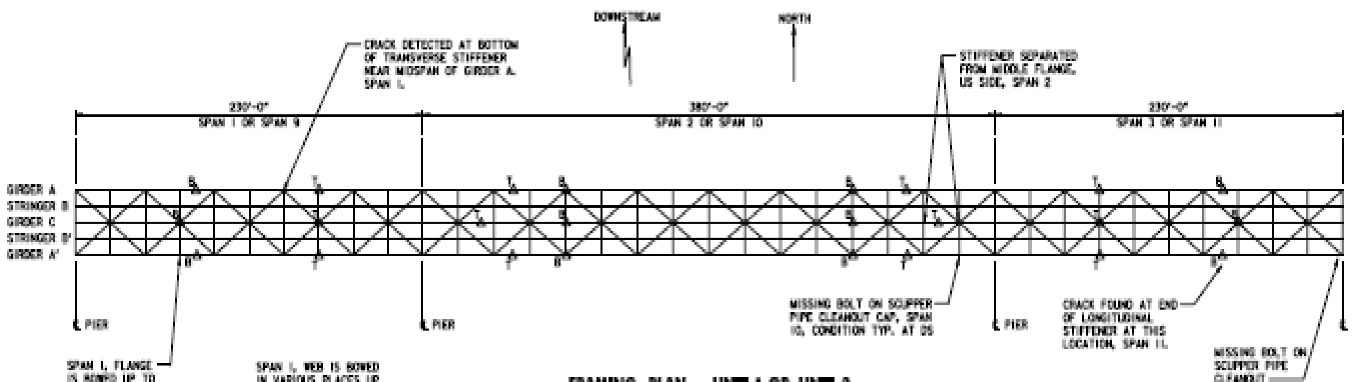


UPSTREAM ELEVATION

SCALE: 1/8" = 10'-0"

NOTE:
DIAGONAL HAIRLINE CRACKS IN CAP OF LEFT END DAM PIER, US WEST SIDE AND US & DS EAST SIDE.

NOTE:
DIAGONAL HAIRLINE CRACKS IN CAP, ALL FOUR SIDES.



FRAMING PLAN – UNIT 1 OR UNIT 3

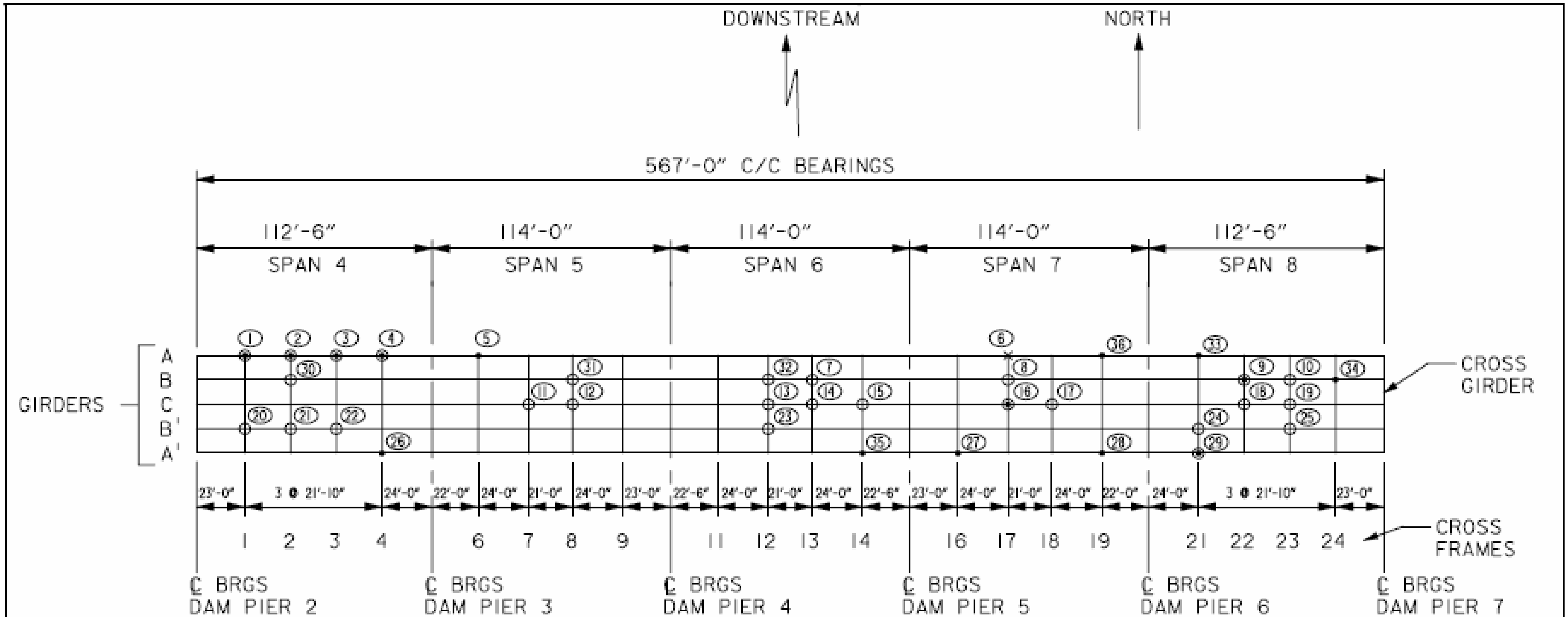
B: BOTTOM LONGITUDINAL STIFFENER RETROFIT LOCATION
T: TOP LONGITUDINAL STIFFENER RETROFIT LOCATION

OBSERVED BY: JBS/MWL   DATE: 9/9/03

Longitudinal stiffener termination, Girder A’, Span 11, Unit 3

Crack at the Termination of the Longitudinal Web Stiffeners

Close-up view of cracked longitudinal stiffener termination.



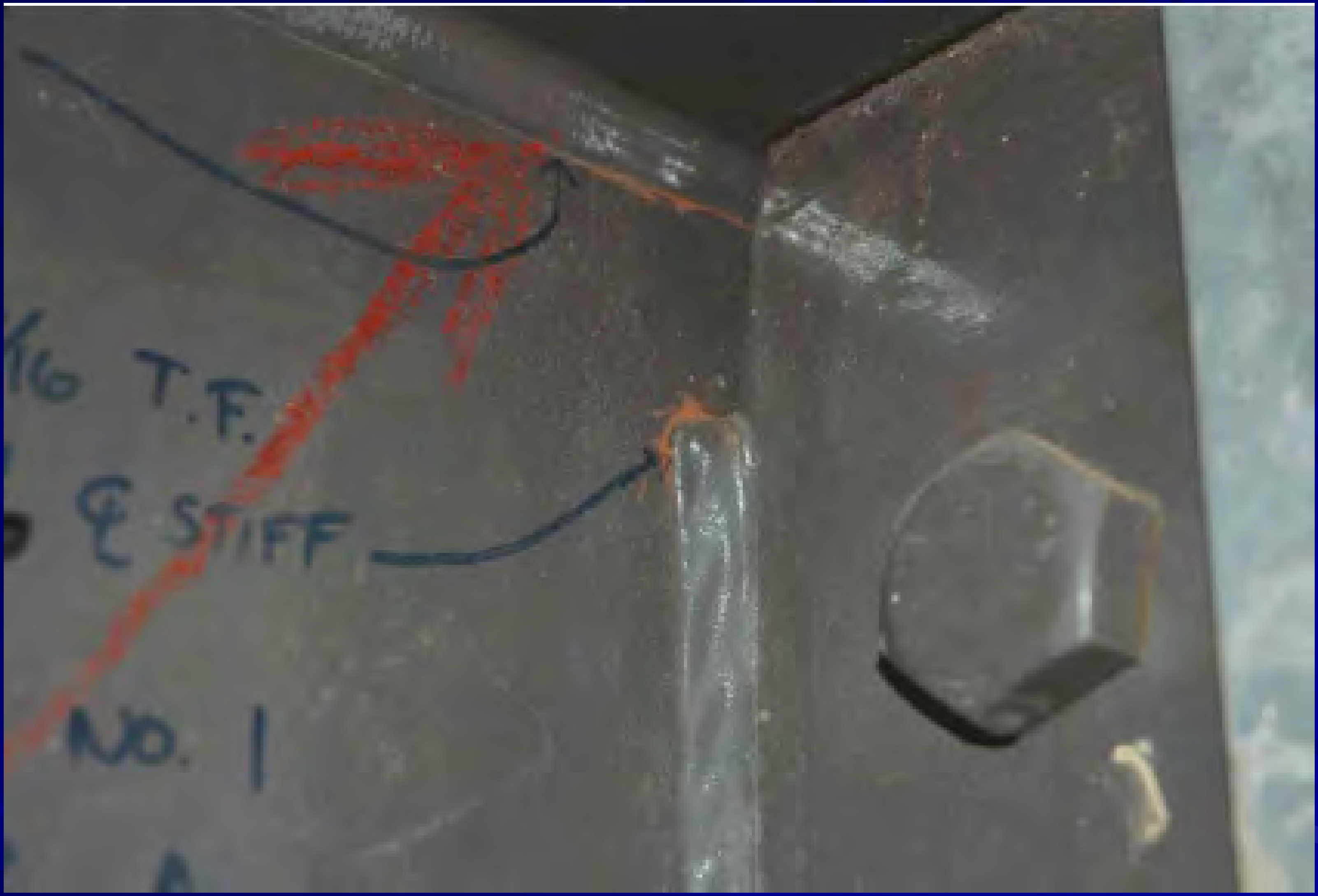
CRACK LOCATION PLAN (SUPERSTRUCTURE 2)

- • TYPE 1 CRACK BELOW WEB - FLANGE WELD
- ○ TYPE 2 CRACK ABOVE STIFFENER - WEB WELD
- × TESTING INDICATED NO ACTUAL CRACK

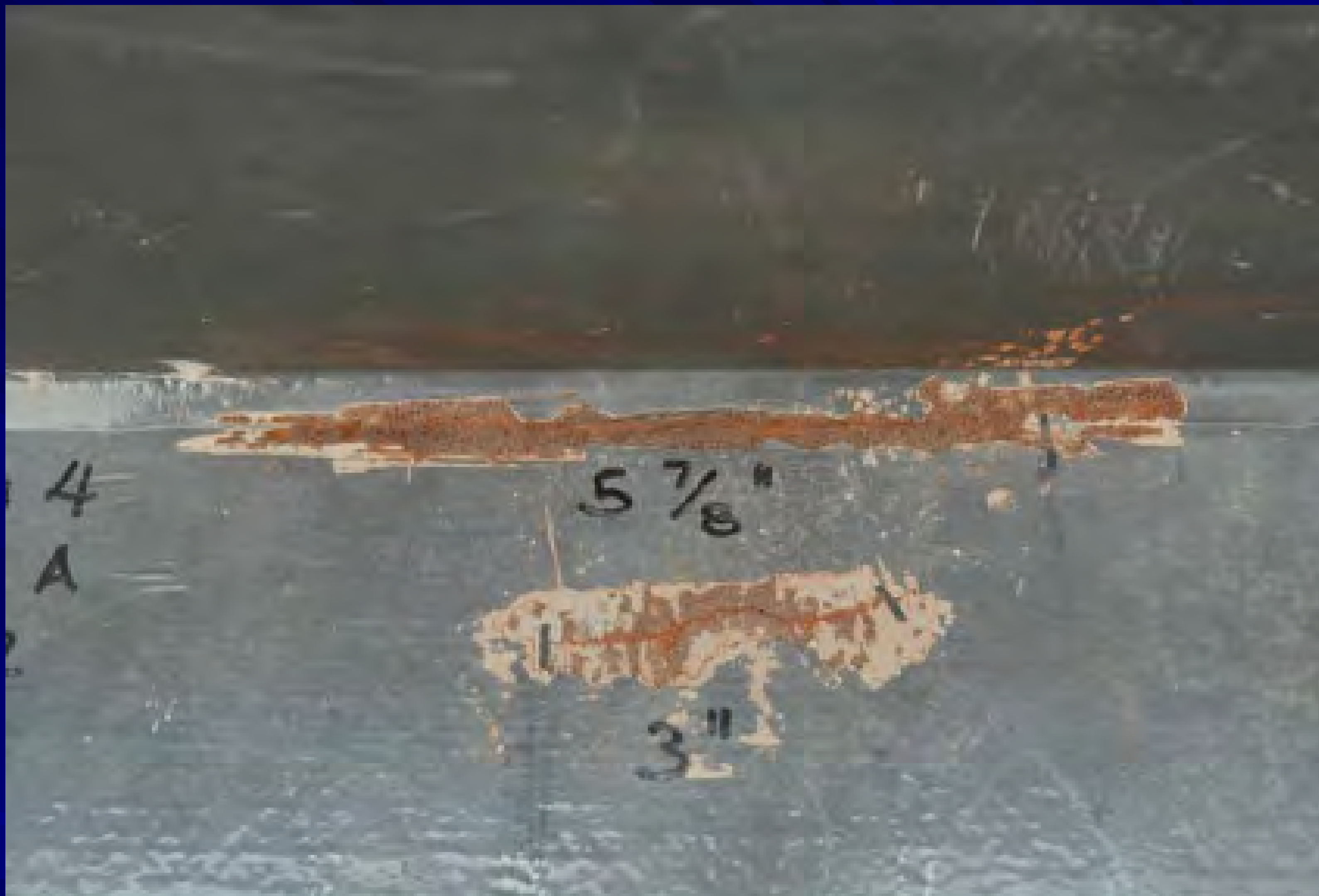
SEE DETAIL

① TEST NUMBER

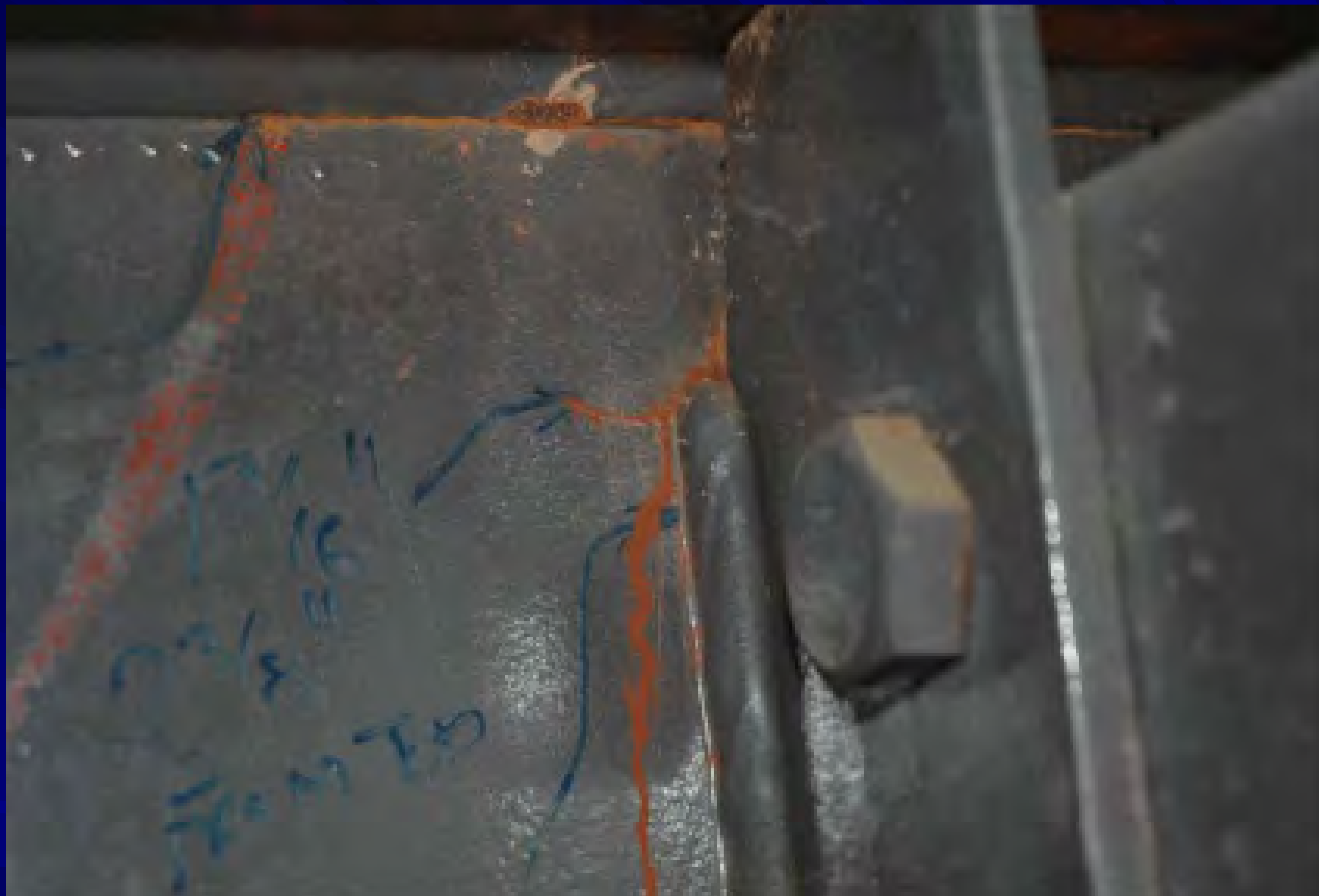
JESSE STUART HIGHWAY BRIDGE
GREENUP LOCKS AND DAM OHIO RIVER
SEPTEMBER 9, 2003



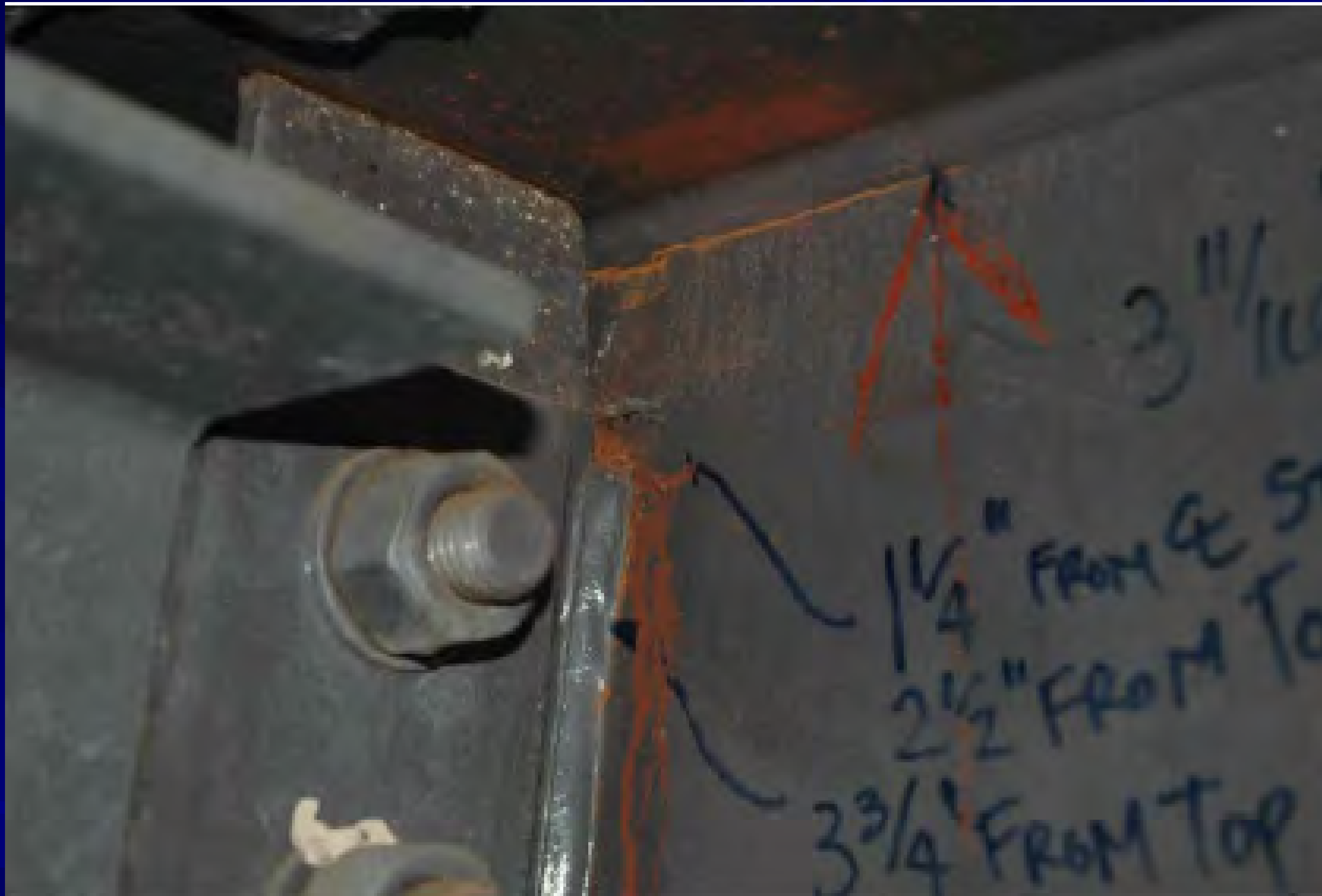
Web gap cracking at inside (upstream) web face
at Cross Frame 1, Span 4 of Girder A, Unit 2.



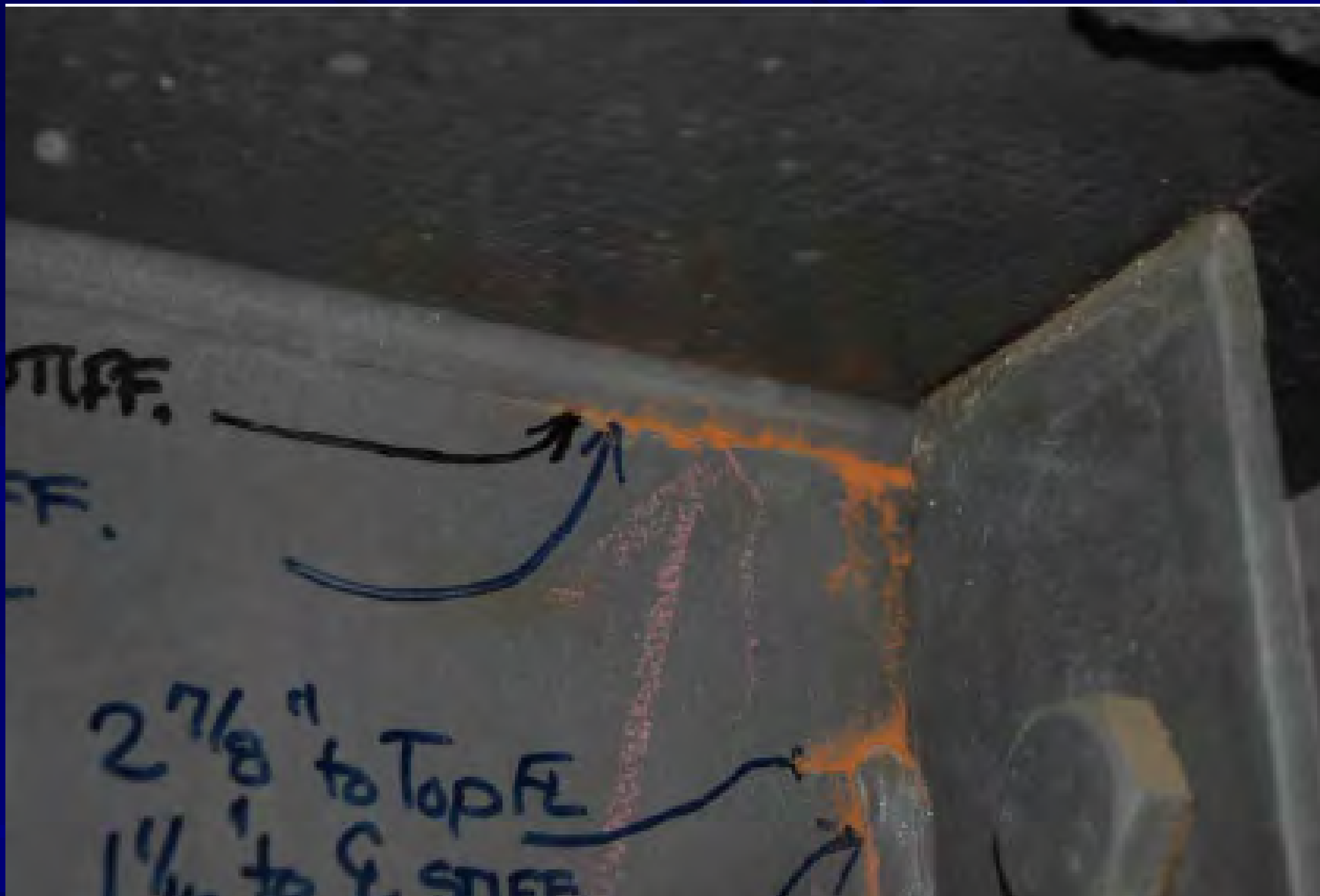
Web gap cracking at outside (downstream) web face at
Cross Frame 2, Span 4 of Girder A, Unit 2.



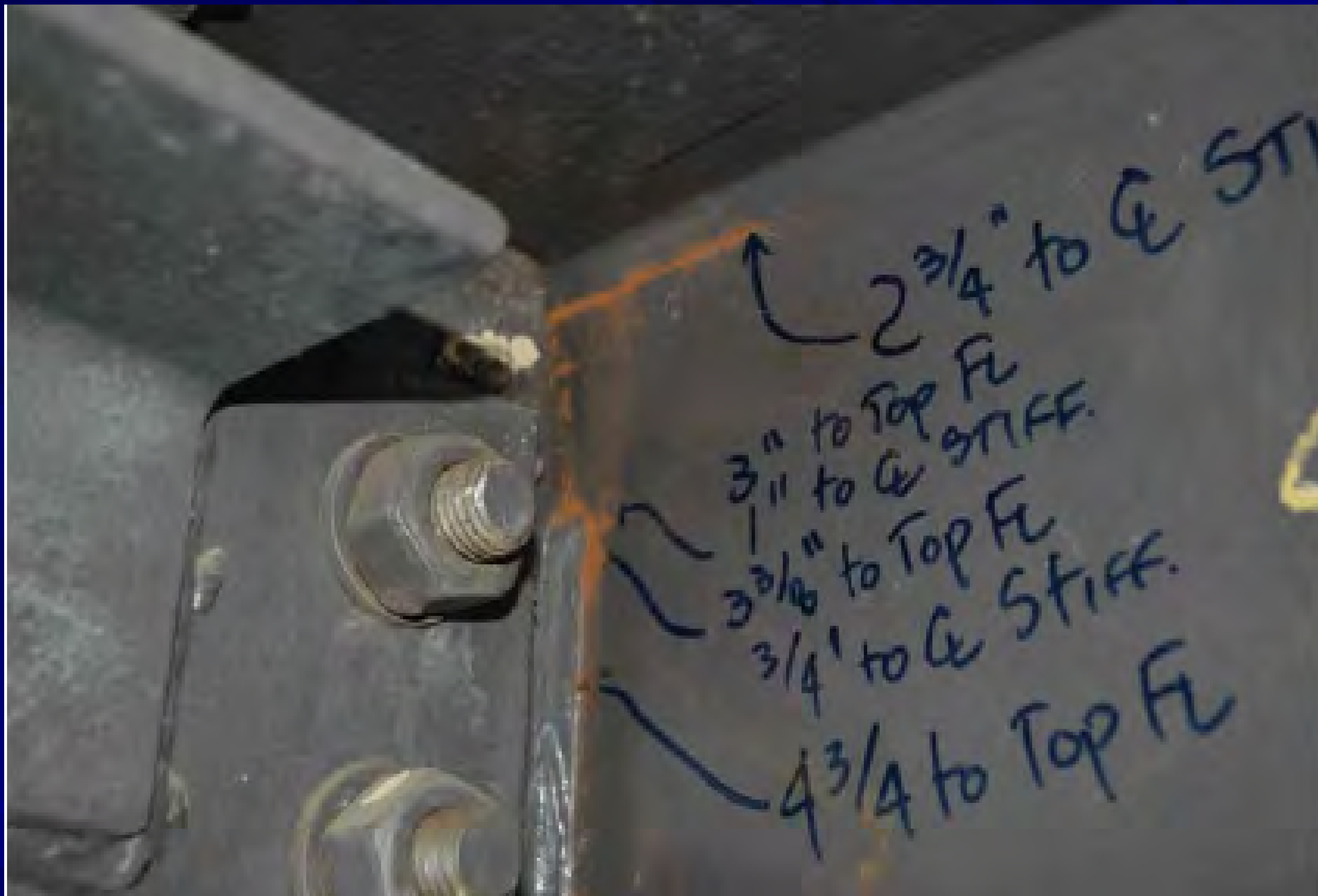
Web gap cracking at inside (upstream) face at
Cross Frame 2, Span 4 of Girder A, Unit 2.



Web gap cracking at inside (upstream) face at
Cross Frame 2, Span 4 of Girder A, Unit 2.



Web gap cracking at inside (upstream) face at
Cross Frame 3, Span 4 of Girder A, Unit 2



Web gap cracking at inside (upstream) face at Cross Frame 3, Span 4 of Girder A, Unit 2.

Web gap cracking at outside (downstream) web face at Cross Frame 3, Span 4 of Girder A, Unit 2.

General Types of Fatigue Cracking

- Load-Induced
- Distortion-Induced

Load-Induced Fatigue Cracking

- Nominal Stress Range
- Number of Applied Load Cycles
- Connection Details

Load-Induced Fatigue
(Type 3 Cracking)

- Longitudinal Stiffener Termination
  - Category E Detail
  - Stress Range 6.3 ksi < 13.0 ksi
  - Termination Opposite a Transverse Stiffener

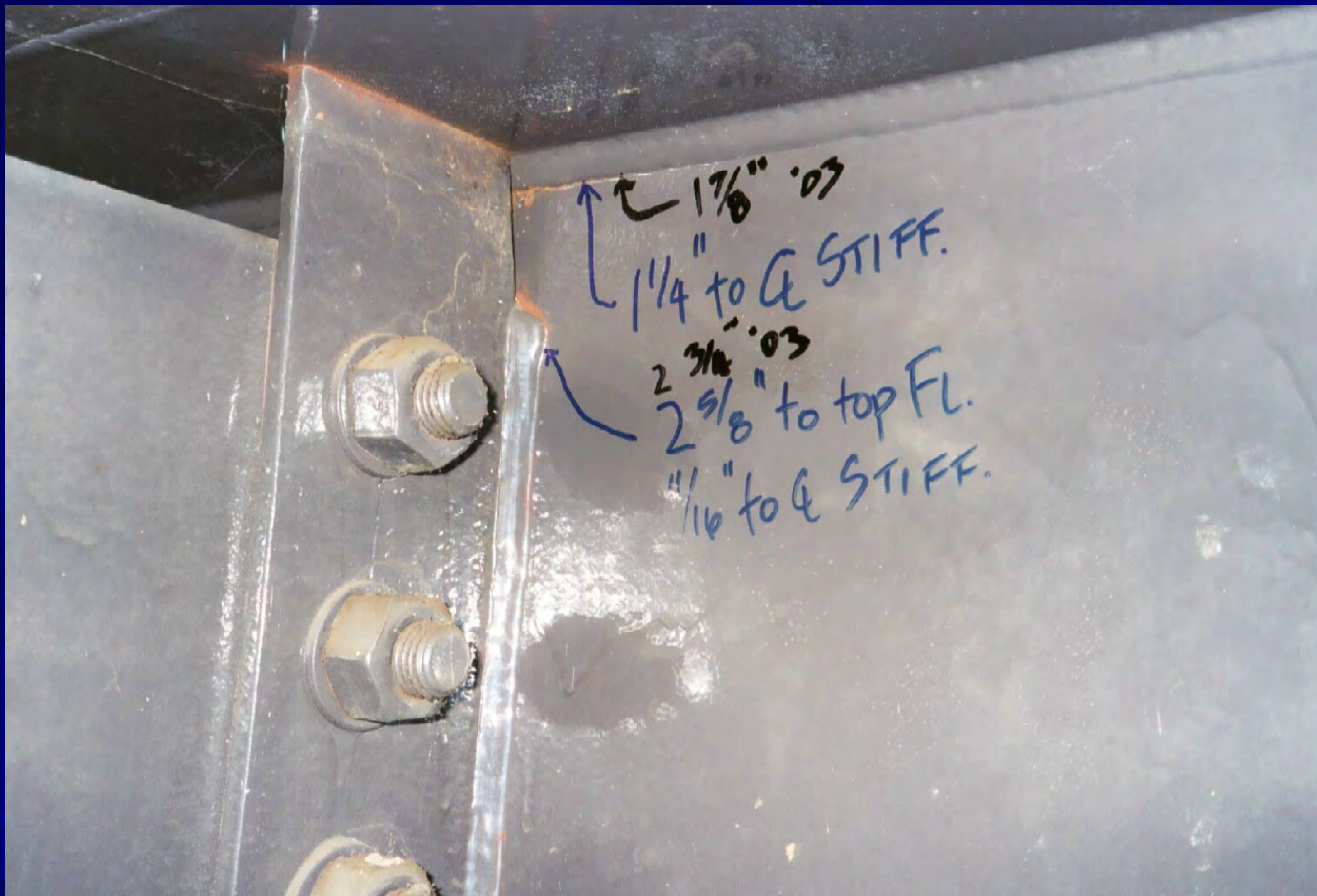
Distortion-induced Fatigue Cracking (Type 1 & 2 Cracking)

- Stress Ranges Complex
- Localized Stresses unintended/Unknown
- Out-of-Plane Distortion

View of typical cross frame in Unit 2.

Distortion-Induced Fatigue

- Transverse Stiffener Connection
  - “Tight Fit (No Weld)”



Typical Cracks in Center Spans

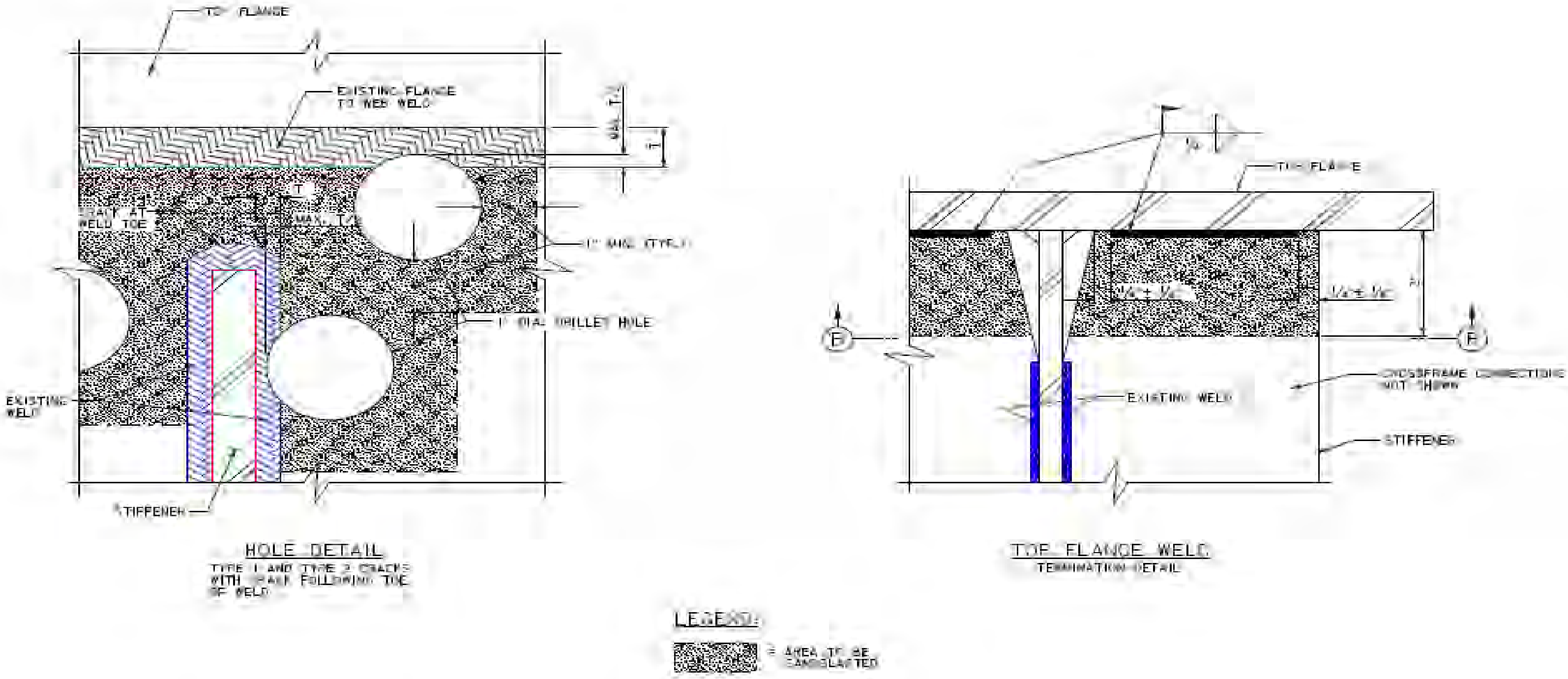
***Note measurements from Periodic Inspections. Blue writing is from FY01. Black writing is from FY03. Top crack grew 5/8” and the lower crack grew 1/8” in a two year period.**

View of typical cross frame in Unit 1 (and Unit 3).

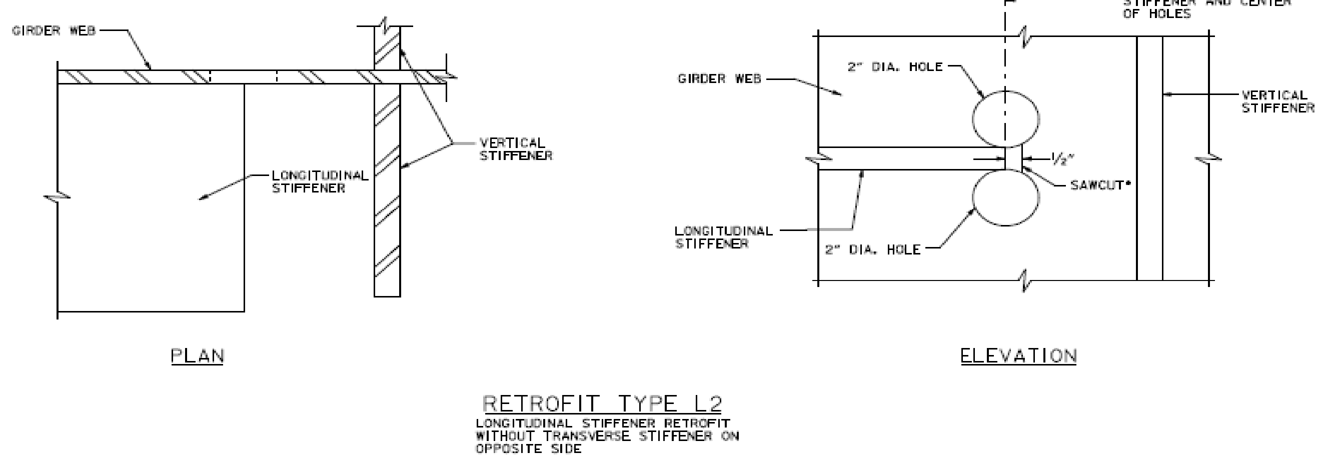
Fracture Assessment

- Three Charpy V-Notch impact test specimens were tested from each of Units 2 and 3.
- Unit 2 web specimens averaged energy absorption is 261 ft-lbf.
- Unit 3 web specimens averaged energy absorption is 38 ft-lbf (low value 29 ft-lbf)
- Test temperature 40F corresponding to AASHTO Temperature Zone 2
- AASHTO required minimum energy absorbed value is 25 ft-lbf for ASTM 588 in Temperature Zone II.
- LEFM used to assess Type 3 crack as “thru-thickness in infinite wide plate”.
- Critical crack length is conservatively twice the existing length of 2.25”.

Retrofit for Type 1 and Type 2 Cracks.



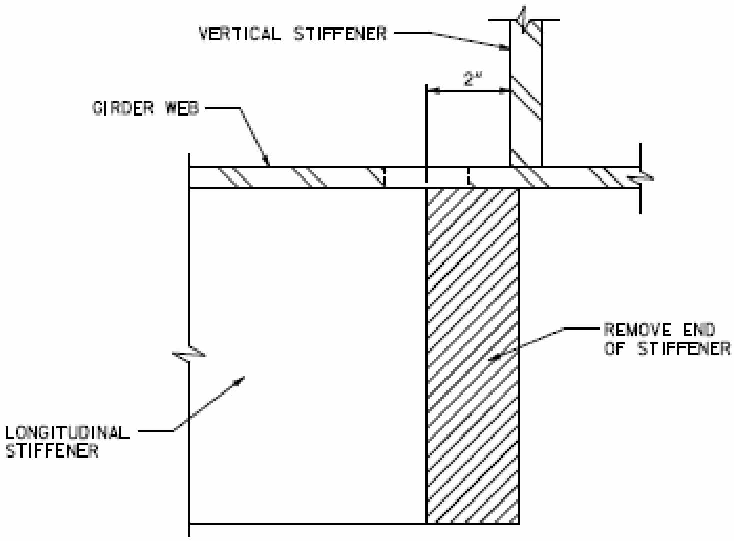
Retrofit for Type 3 Crack



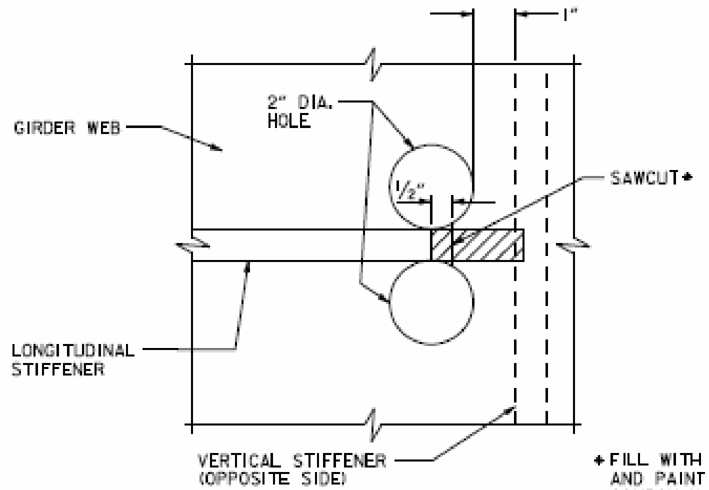
Summary

- 42 fatigue cracks exist as of September 2003
- Probable cause is load-induced and distortion-induced fatigue cracking
- Limited material testing indicates adequate fracture toughness for webs
- Observed Type 1, 2, & 3 cracking does not impose an immediate structural threat.
- Existing web gap cracking does not reduce load-carrying capacity of girders.
- Permitted loads will be assessed and limited where possible.

Discussion!



PLAN



ELEVATION

* FILL WITH CAULK PRIOR TO PRIMING AND PAINTING. CAULK SHALL BE A TWO-COMPONENT, NON-SAG, NON SHRINK 100 PERCENT SOLIDS EPOXY CAPABLE OF FILLING VOIDS UP TO 1/2 INCH.

RETROFIT TYPE L1

LONGITUDINAL STIFFENER RETROFIT WITH TRANSVERSE STIFFENER ON OPPOSITE SIDE

US Army Corps
of Engineers
Chicago District

2005 Tri-Service Infrastructure Conference

St. Louis, Mo. August 4, 2005

Design of Concrete Lined Tunnels in Rock

CUP McCook Reservoir – Distribution Tunnels Contract

David Force, S.E.

US Army Corps
of Engineers
Chicago District

Outline of Presentation

- General Project overview – McCook Reservoir Project
- Overview of Distribution Tunnels Contract
- Design of Circular Tunnel Lining on Distribution Tunnels Contract
- Design of Concrete Bifurcations on Distribution Tunnels Contract
- Overview of Steel Liner Design on Distribution Tunnels Contract

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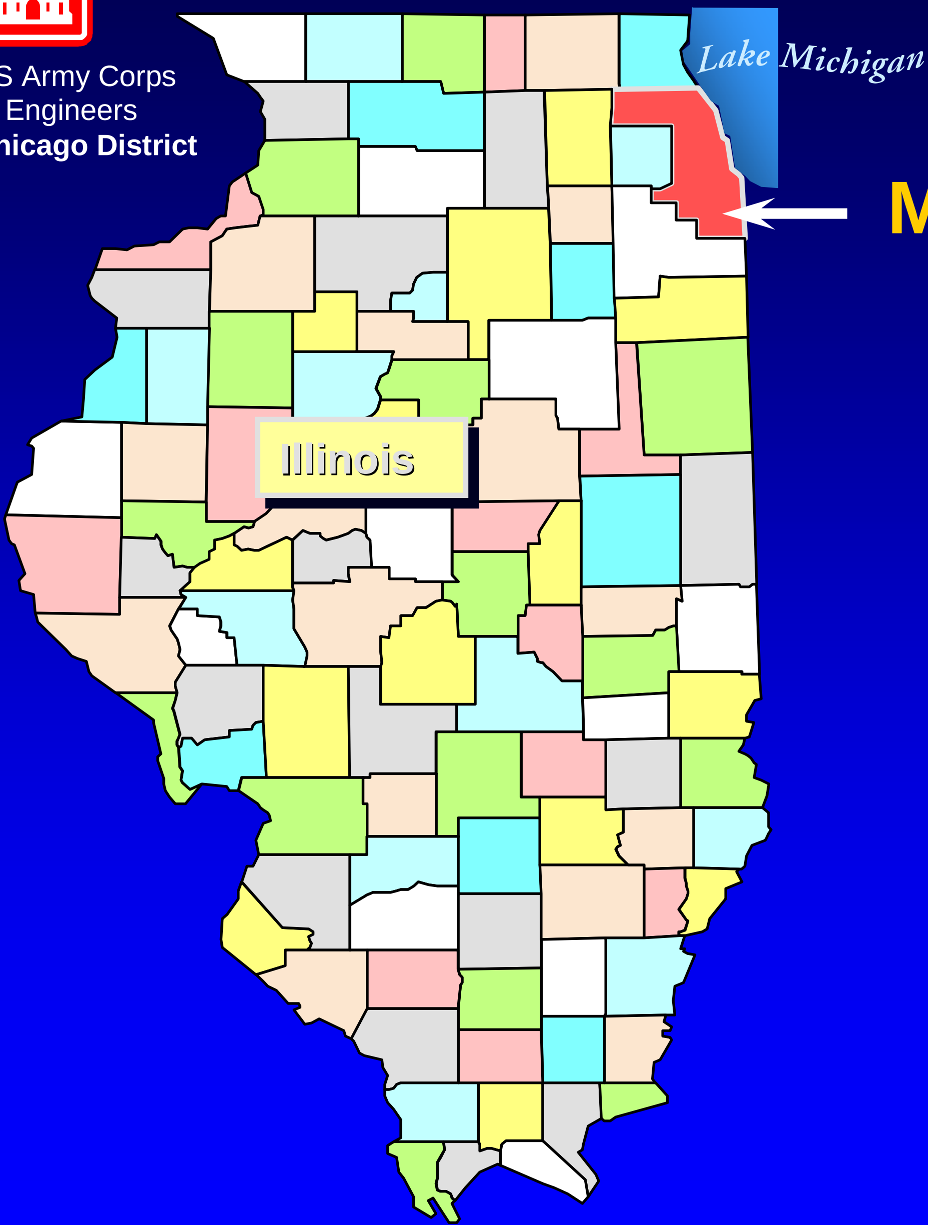
McCook Reservoir Project

US Army Corps
of Engineers
Chicago District



MWRDGC

Metropolitan

Water

Reclamation

District of

Greater

Chicago

US Army Corps
of Engineers
Chicago District

Overall Goal – Control Flooding and Keep CSO Out of Lakes and Rivers !

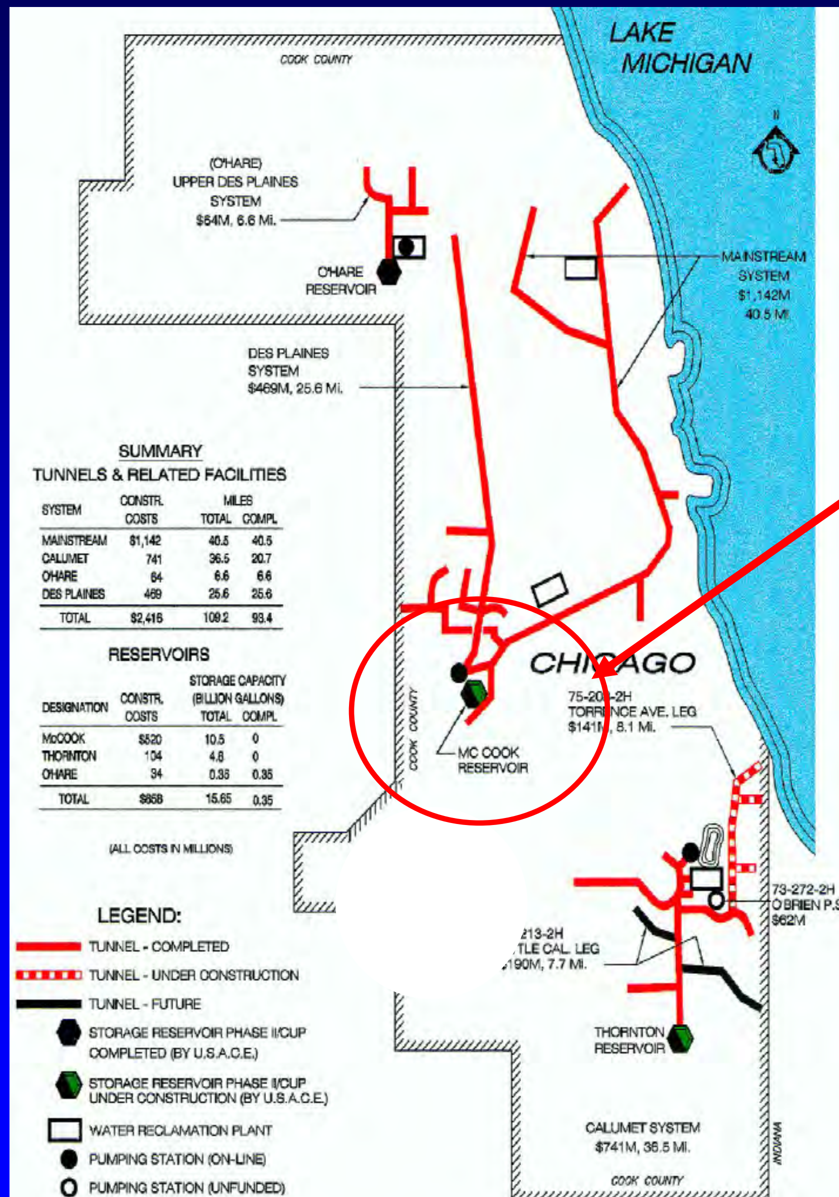
US Army Corps
of Engineers
Chicago District

McCook Reservoir

- Estimated cost $520 million
- Provides flood control between Des Plaines River and Chicago Sanitary and Ship Canal
- Excavation of reservoir will be by Drill and Blast (Quarrying)
- Captures CSO’s from Chicago and 37 suburbs
- Provides > 10 billion gallons of storage
- Scheduled Project Completion - FY 2012

TARP / CUP SYSTEM

US Army Corps
of Engineers
Chicago District



SUMMARY
TUNNELS & RELATED FACILITIES

SYSTEM	CONSTR. COSTS	MILES TOTAL	MILES COMPL.
MAINSTREAM	$1,142	40.5	40.5
CALUMET	741	36.5	20.7
O'HARE	64	6.6	6.6
DES PLAINES	469	25.6	25.6
TOTAL	$2,416	109.2	93.4

RESERVOIRS

DESIGNATION	CONSTR. COSTS	STORAGE CAPACITY (BILLION GALLONS) TOTAL	COMPL.
McCOOK	$520	10.5	0
THORNTON	104	4.8	0
O'HARE	34	0.35	0.35
TOTAL	$658	15.65	0.35

(ALL COSTS IN MILLIONS)

US Army Corps
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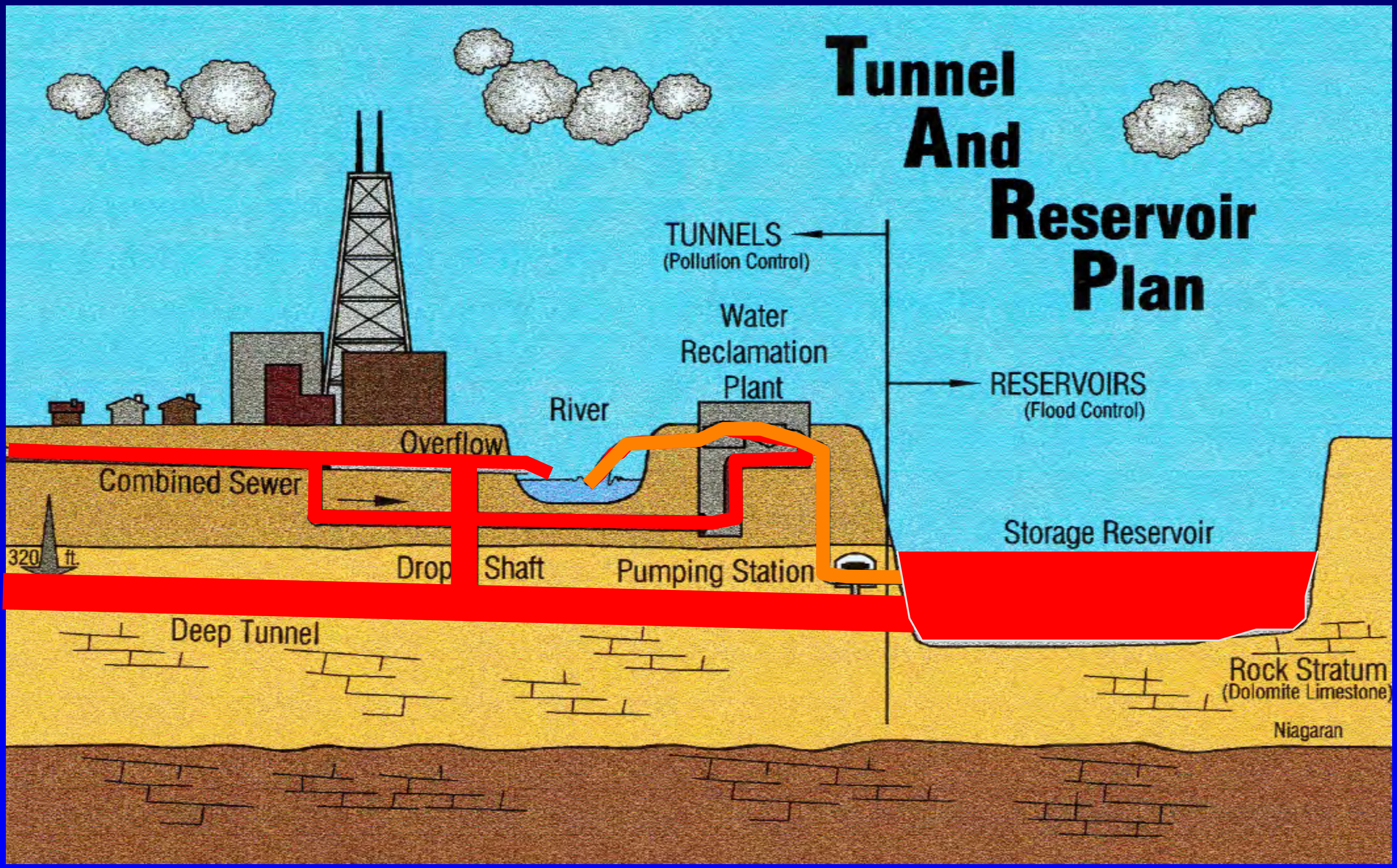
Chicago District



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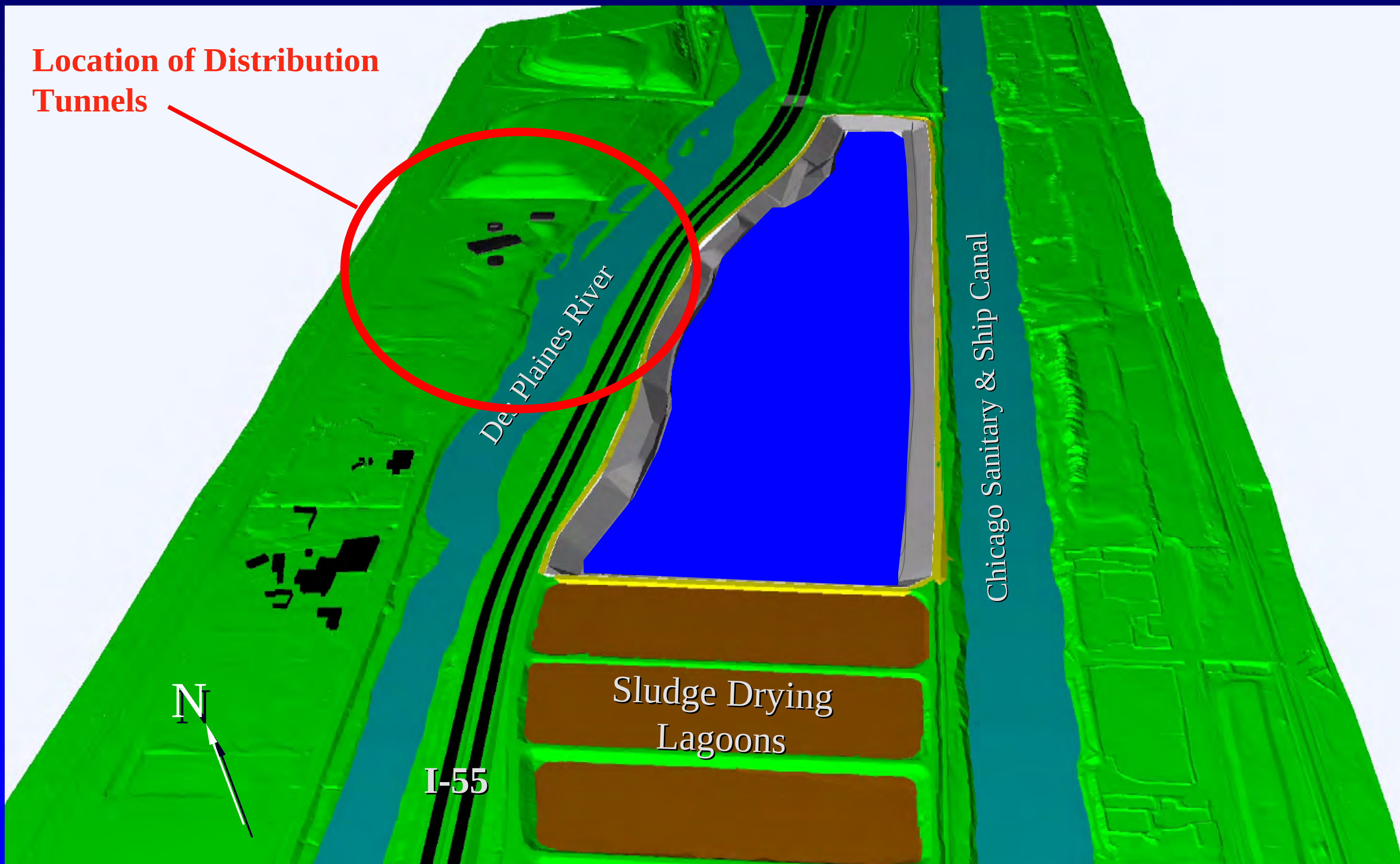
Reservoir Project



US Army Corps
of Engineers
Chicago District

Distribution Tunnels Contract

US Army Corps
of Engineers
Chicago District

Distribution Tunnels Contract

- **LS:** *Metropolitan Water Reclamation District of Chicago (MWRD)*
- **Designer:** *Montgomery Watson Harza*
- **Construction Contractor:** *Kenny Construction*
- **Gate Designer:** *INCA (sub to Kenny)*
- **Steel Liner Fabricator:** *CBI (sub to Kenny)*

US Army Corps
of Engineers
Chicago District

Purpose of Distribution Tunnels

- Convey and Distribute CSO's between the new Reservoir and the existing TARP Pump Stations and Tunnels

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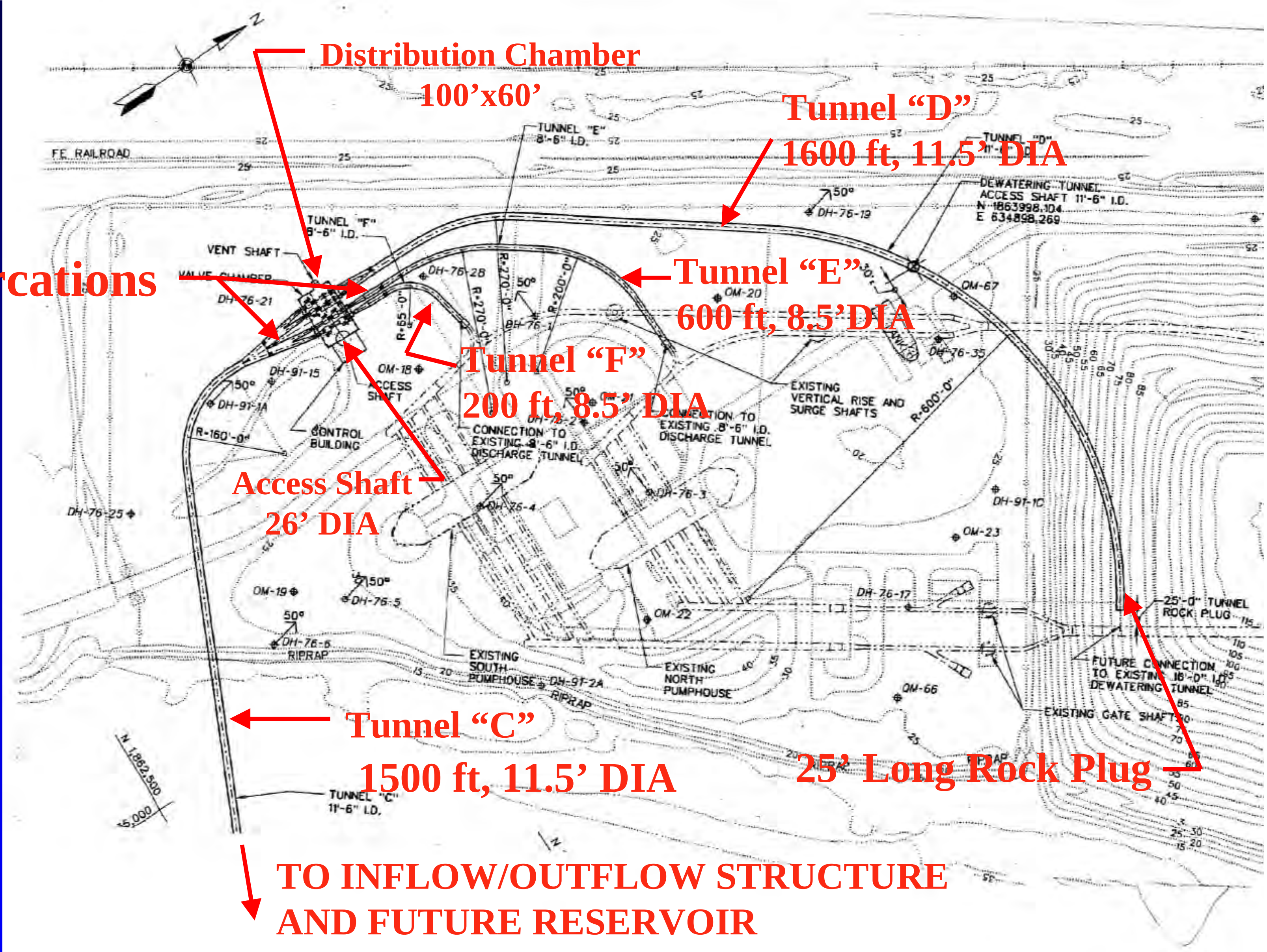

Plan – Distribution Tunnels

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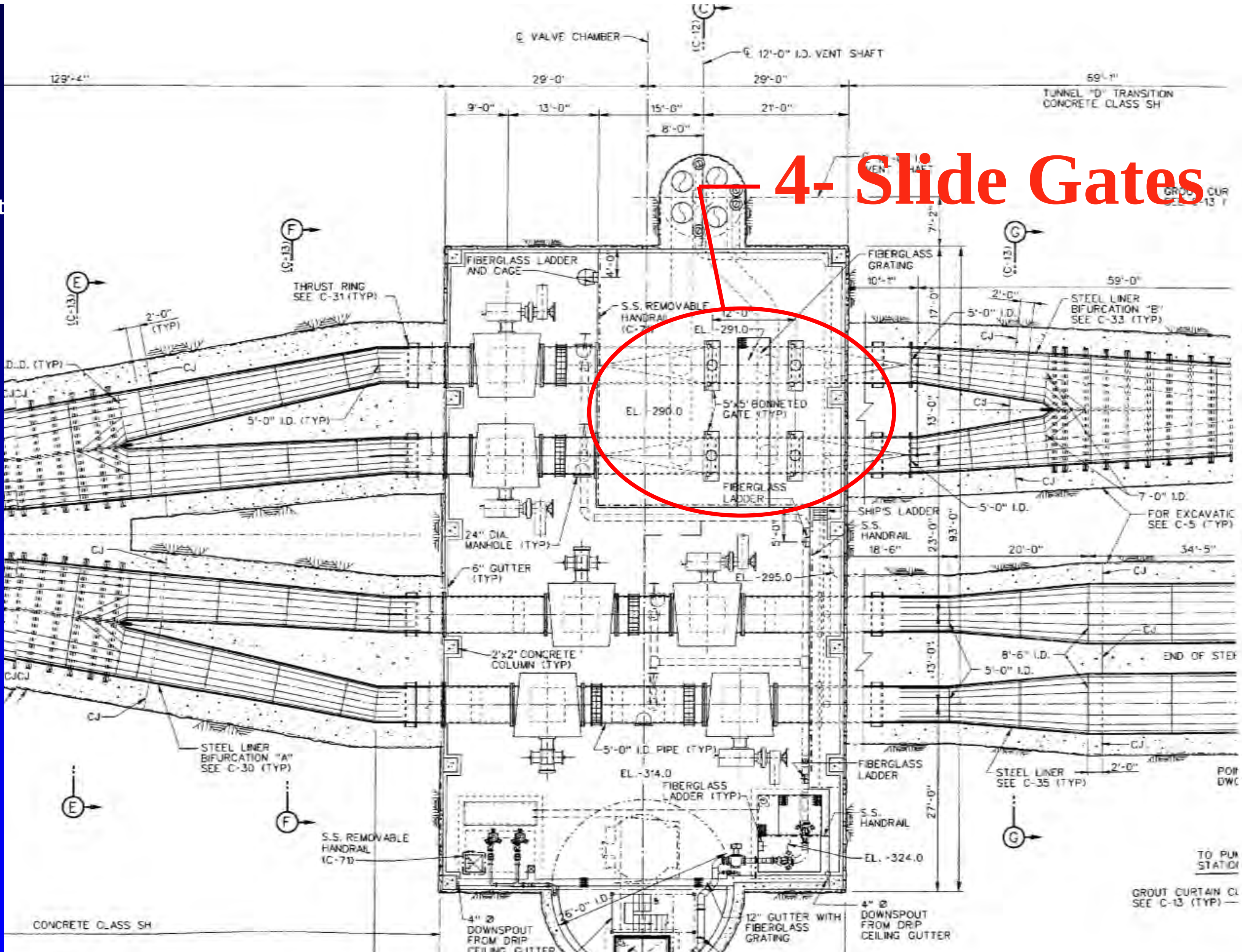
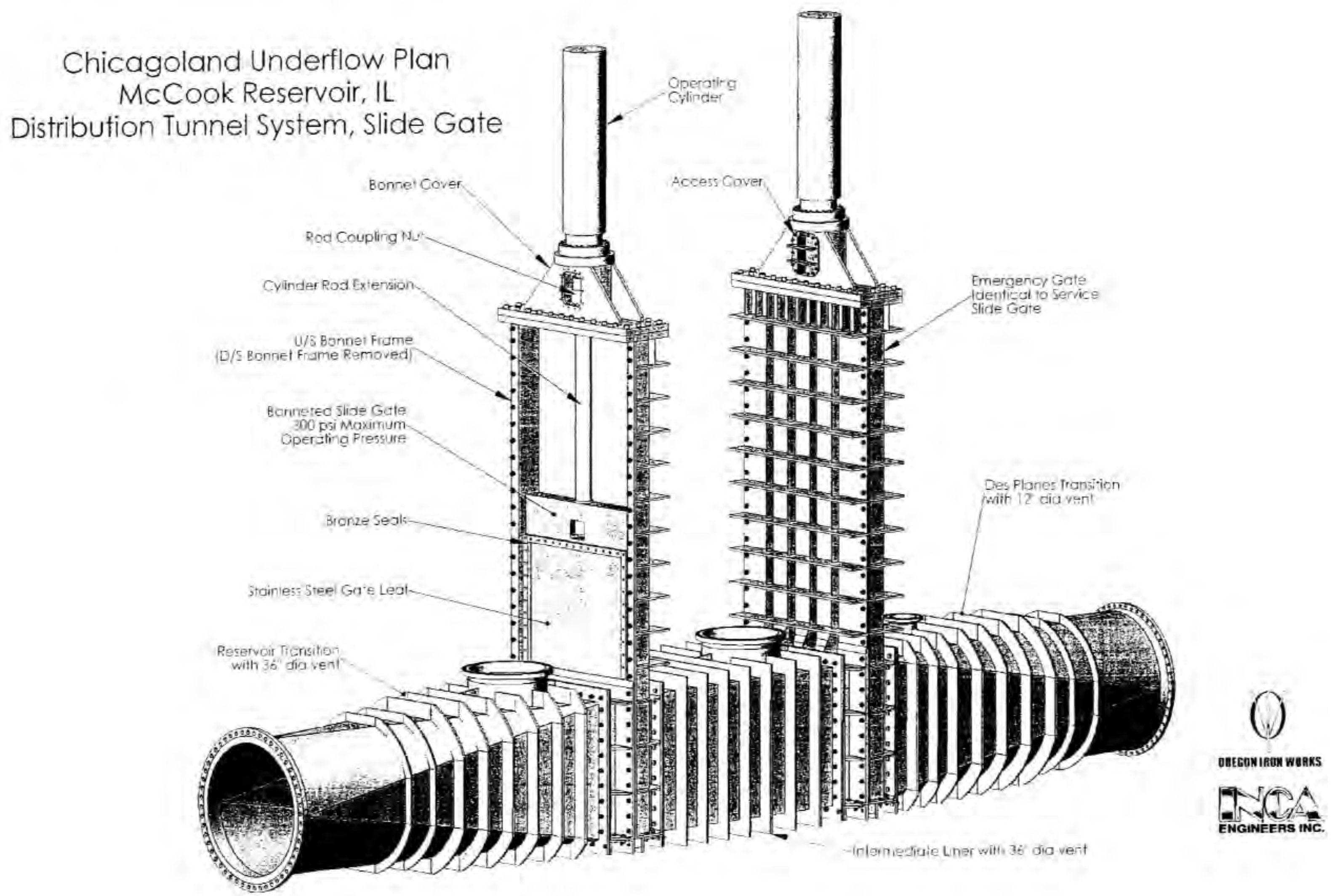


Distribution Chamber

US Army Corps
of Engineers
Chicago District



Bonneted Slide Gates – 5’x 5’

CONTRACT COST/SCHEDULE

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Total contract	$60 million
Completed	85%
Anticipated Completion Date:	Jan 2006

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Design of Circular Tunnel Lining

US Army Corps
of Engineers
Chicago District

EM 1110-2-2901
30 May 1997

US Army Corps
of Engineers

ENGINEERING AND DESIGN

Tunnels and Shafts in Rock

ENGINEER MANUAL

US Army Corps
of Engineers
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Tunnels General

- 3100 Lineal Feet of 11.5’ DIA. Tunnel
  800 Lineal Feet of 8.5’ DIA. Tunnel
- Approximately 310’ below grade
- Excavation by Drill and Blast - Creating a horseshoe shaped excavation

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Tunnel Excavation – Drill and Blast

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Tunnels General (con't)

- **Final Tunnel cross sections are Circular except at bifurcations.**
- **At bifurcations cross sections are oblong or vary between circular and oblong**

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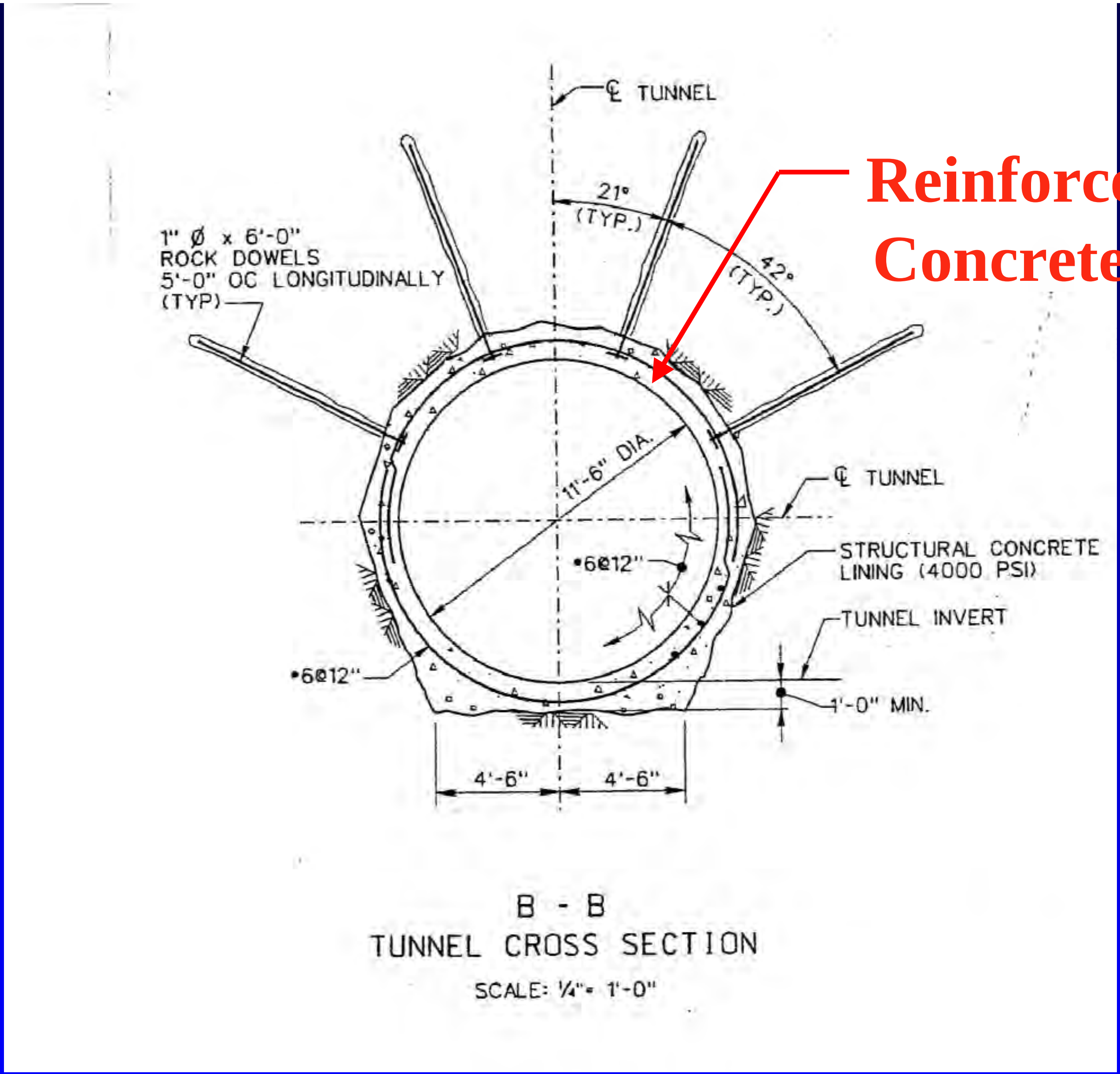

Typical Tunnel Cross Section

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Why Reinforced?

- Most of the Chicago TARP tunnels are not reinforced because;

  \- Exfiltration is not a concern since external pressures from ground water exceed internal pressures

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Why Reinforced? (con't)

On Distribution tunnels reinforcement is provided because;

- The proximity of the reservoir draws groundwater down allowing exfiltration

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Hydraulic Design Considerations

- Velocities > 100 fps can occur around gates and valves in tunnels – those areas are steel lined and backed with 6000 psi concrete

- Tunnel C and D are low velocity gravity – 4000 psi concrete

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Design Loads
Circular Tunnel Liners

- ## Internal Pressures

Max Hydraulic Dynamic Pressure of 160 psi

- ## External Pressure

Hydrostatic Load from Ground Water

head = 310 ft   or 132 to 134 psi

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Key Design Assumptions

- All rock loads are assumed to be fully supported by permanent rock dowels. No rock loads to the liner.

- Relaxation of the rock and stress redistribution is assumed to occur prior to installation of the lining

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Crack Width Limitation (Internal Pressure Design)

- Crack Width Limited to .008” for water tightness
- Tensile stresses in the reinforcing are limited to limit the crack width.

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Materials

- **Concrete strength:**

  4000 psi in tunnels

  6000 psi around steel liners

  10,000 psi at concrete bifurcation

- **Reinforcing:**

  ASTM A615, GR 60

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Analyses Procedure

Tunnel Lining is analyzed for Internal External pressure

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External Pressure Design Procedure

1. Determine and apply external pressures:

   132 psi for 11.5’ diameter tunnels

2. Determine Load Case(s):

   1.1 D + 1.4 H (EM 2901, Table 9-1)

3. Model tunnel Lining using STAAD

4. Design Concrete for Hoop Compression

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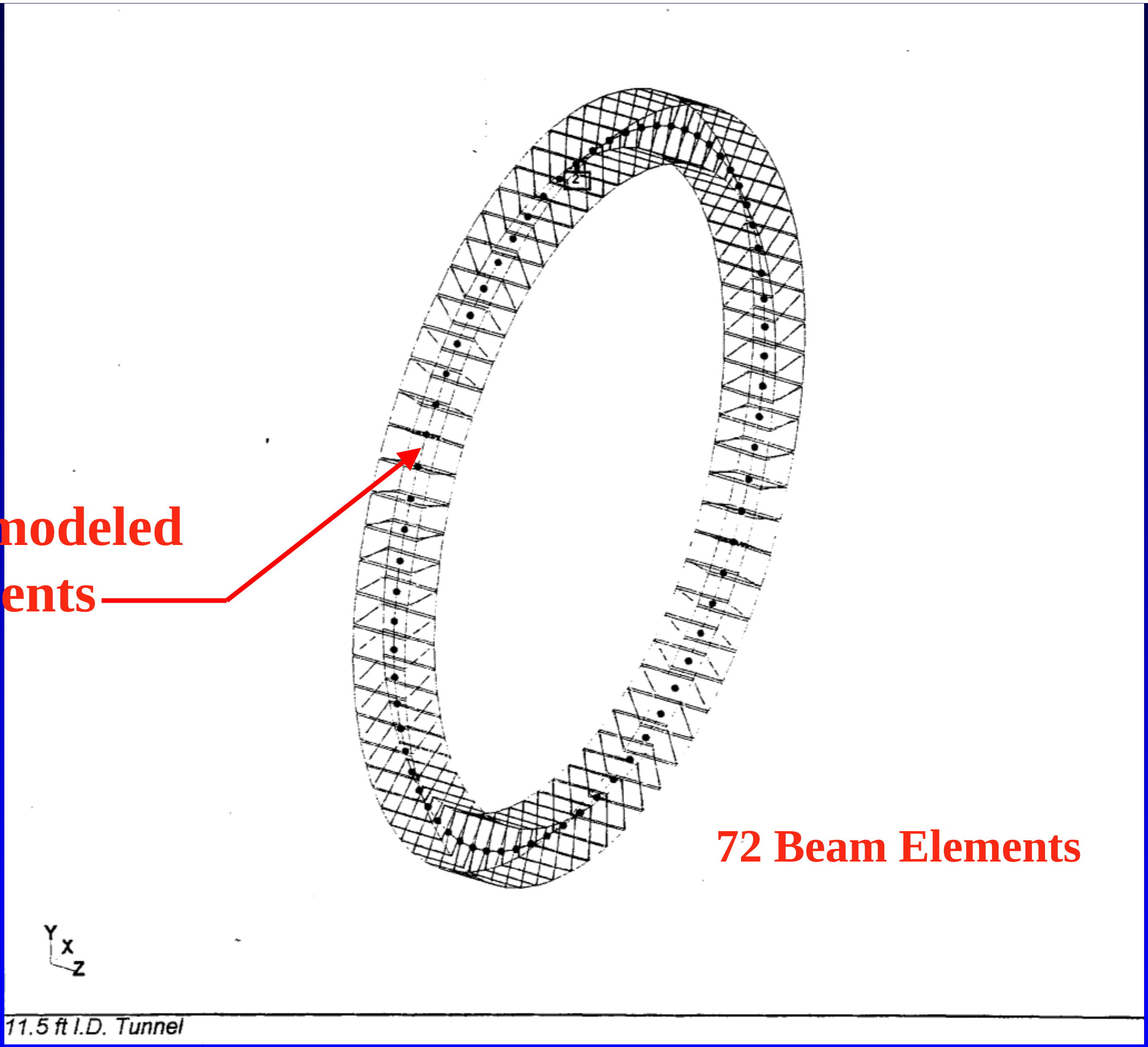
Tunnel Lining modeled with beam elements



STAAD FE Model

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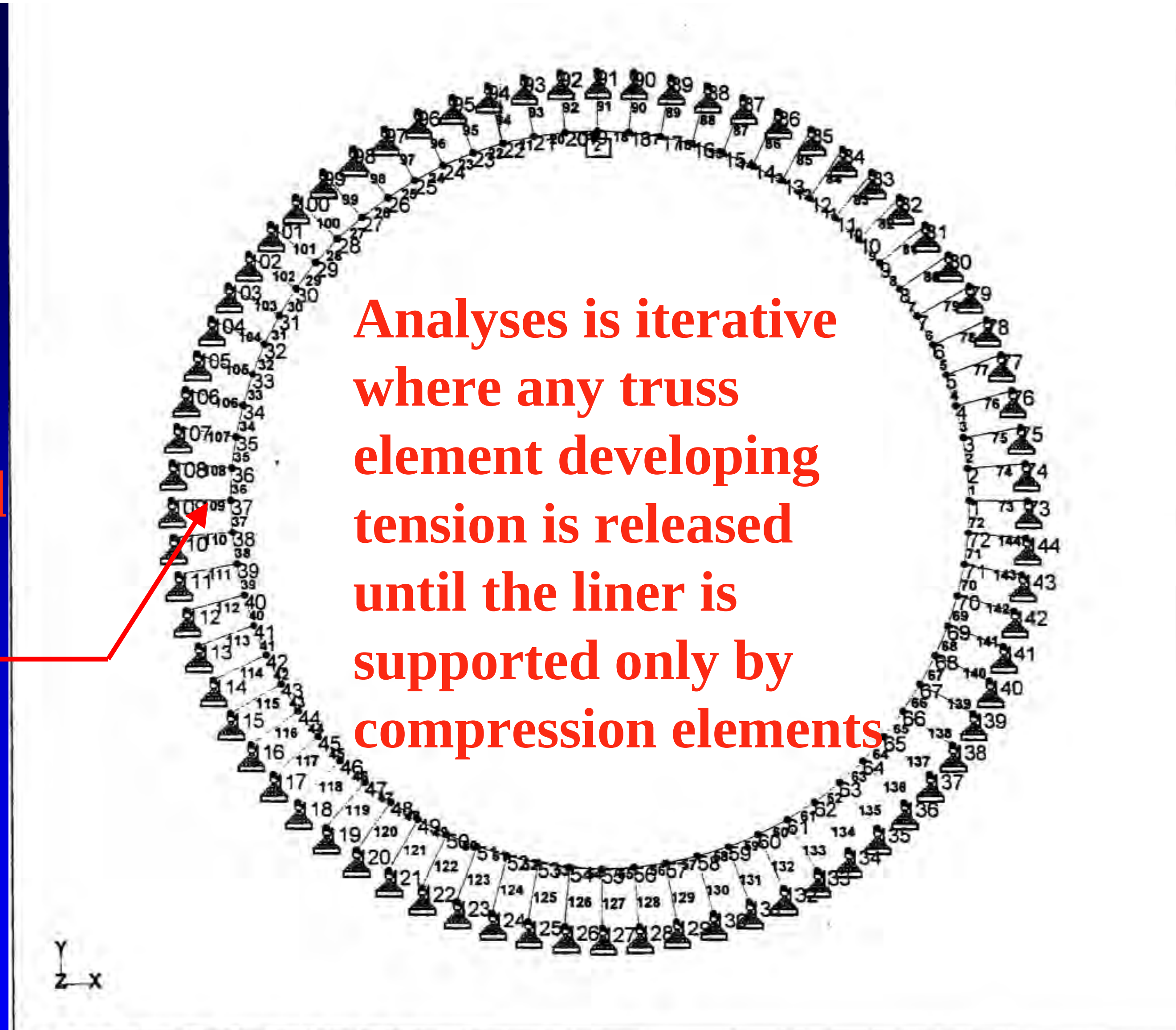
STAAD Model

Rock Modeled With truss elements

Radial spring Stiffness assigned Per Equation 9-18, EM 2901.

Analyses is iterative where any truss element developing tension is released until the liner is supported only by compression elements



11.5 ft I.D. Tunnel (Beam and Node Numbers)

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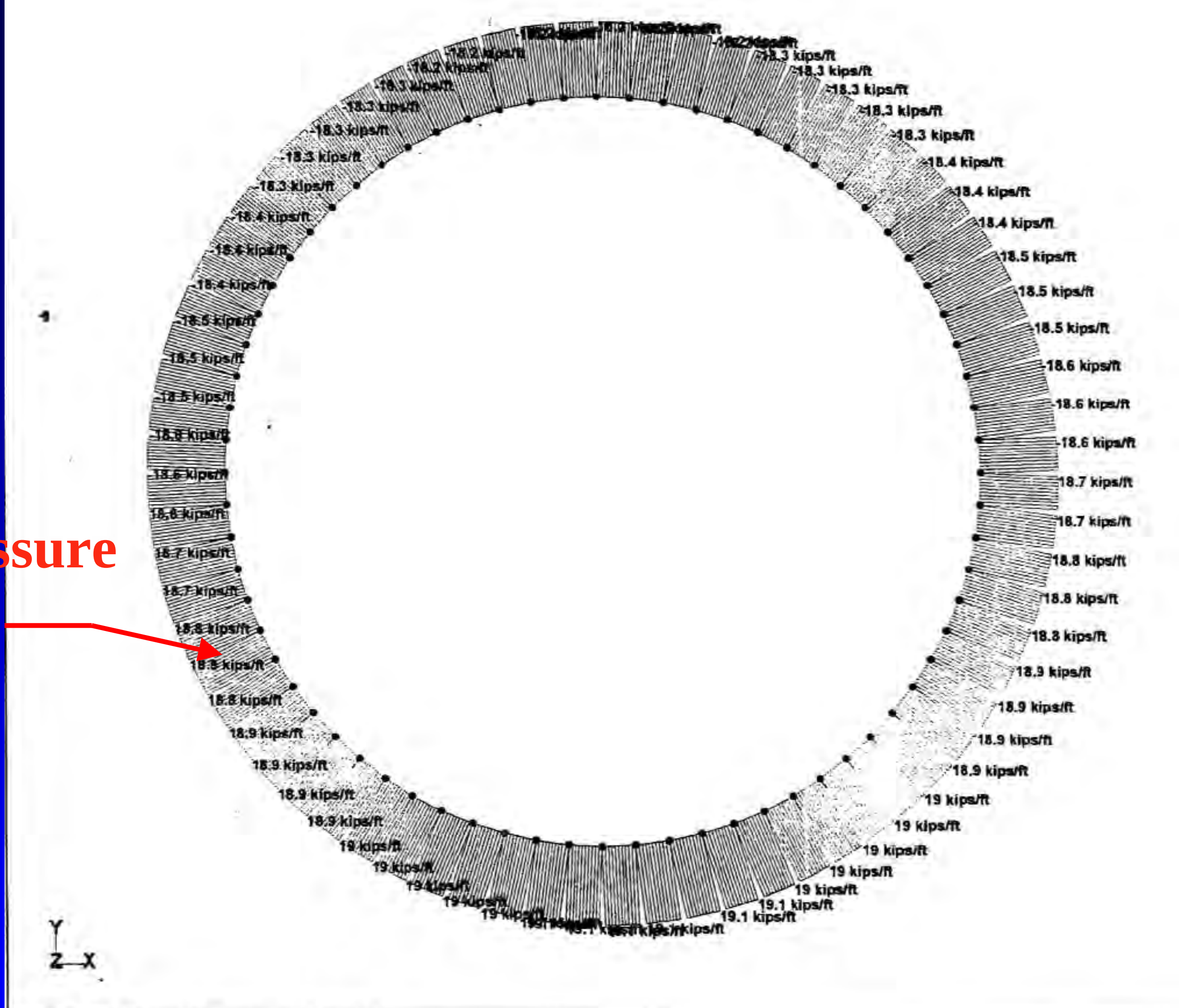
External Pressure
Load 132 psi



11.5 ft I.D. Tunnel (Pressure Loads)

STAAD Model

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Results – External Pressure Design

- Primary Load is hoop compression

Pu = 164 K/FT   for 11.5' Tunnels

- Moments and Shears are negligible

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Internal Pressure Design Procedure

1. Determine and apply internal pressures:

   160 psi ………….11.5’ diameter tunnels

2. Determine Load Case(s):

   1.1 D + 1.4 H (EM 2901)

3. Model the tunnel using Program “TUNNEL” developed by MWH.

4. Design Reinf. to Limit crack width to .008”

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Model Features
(Internal Pressure Design)

1. Surrounding Rock Mass was modeled as a thick walled cylinder

2. Deformation properties of the concrete lining and sound and fissured rock were modeled.

3. Strain compatibility was performed to determine % of load carried by the rock and the lining.

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Rock Properties
(Internal Pressure Design)

- A 40” ring of fissured rock was modeled – due to drill and blast excavations.
- Then, sound rock was modeled beyond the fissured zone

Fissured Rock (grouted) …….Erock = 480,000 psi

Sound Rock ……………………..Erock = 1,300,000 psi

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Results
(Internal Pressure Design)

- Primary Load was tensile stress in the Concrete.

  Maximum Tensile Stress = 600 psi

- Reinforcement was sized to limit crack width to .008 inches

- Resulted in #6 @12 inches

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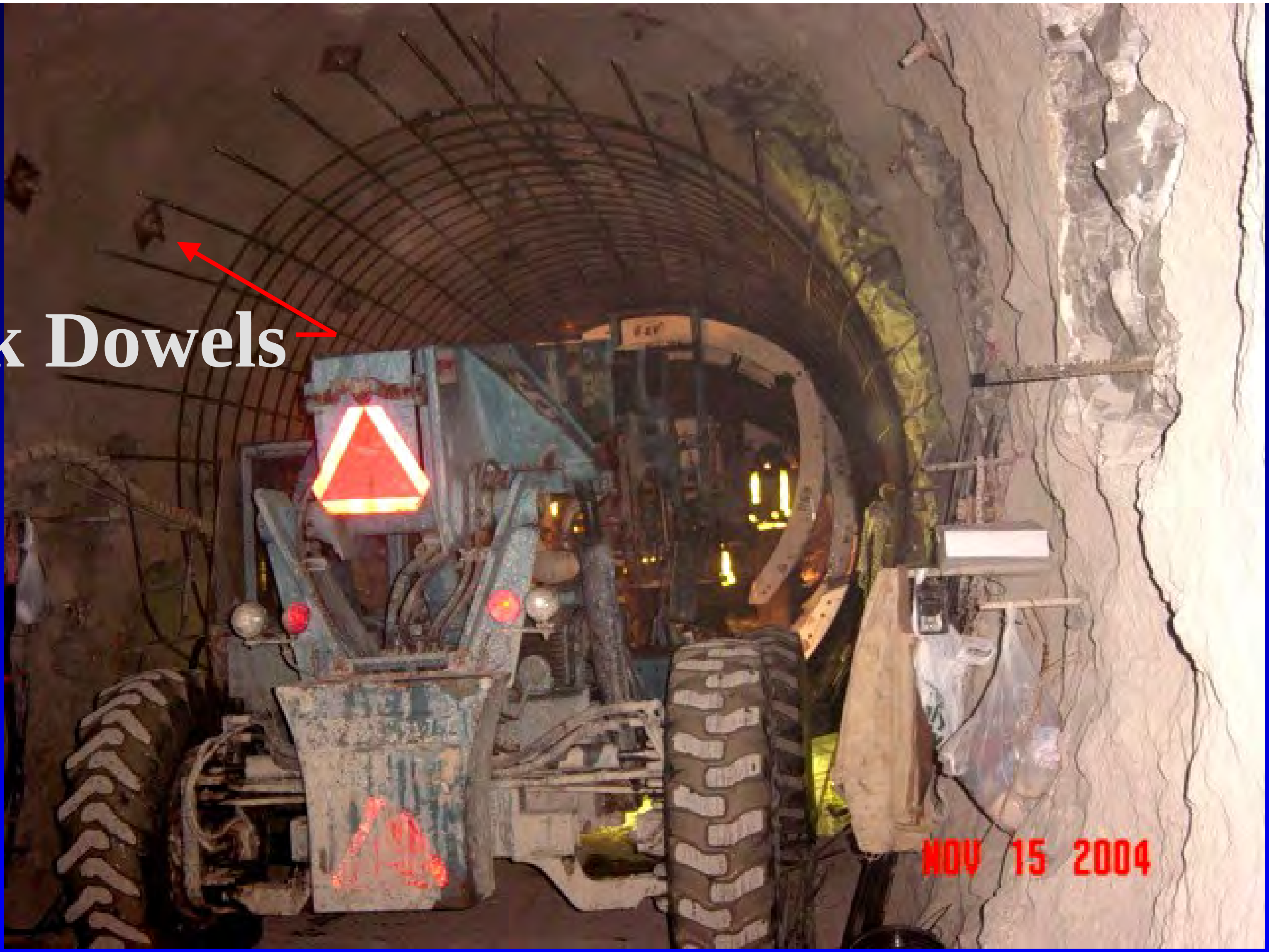

Setting Forms

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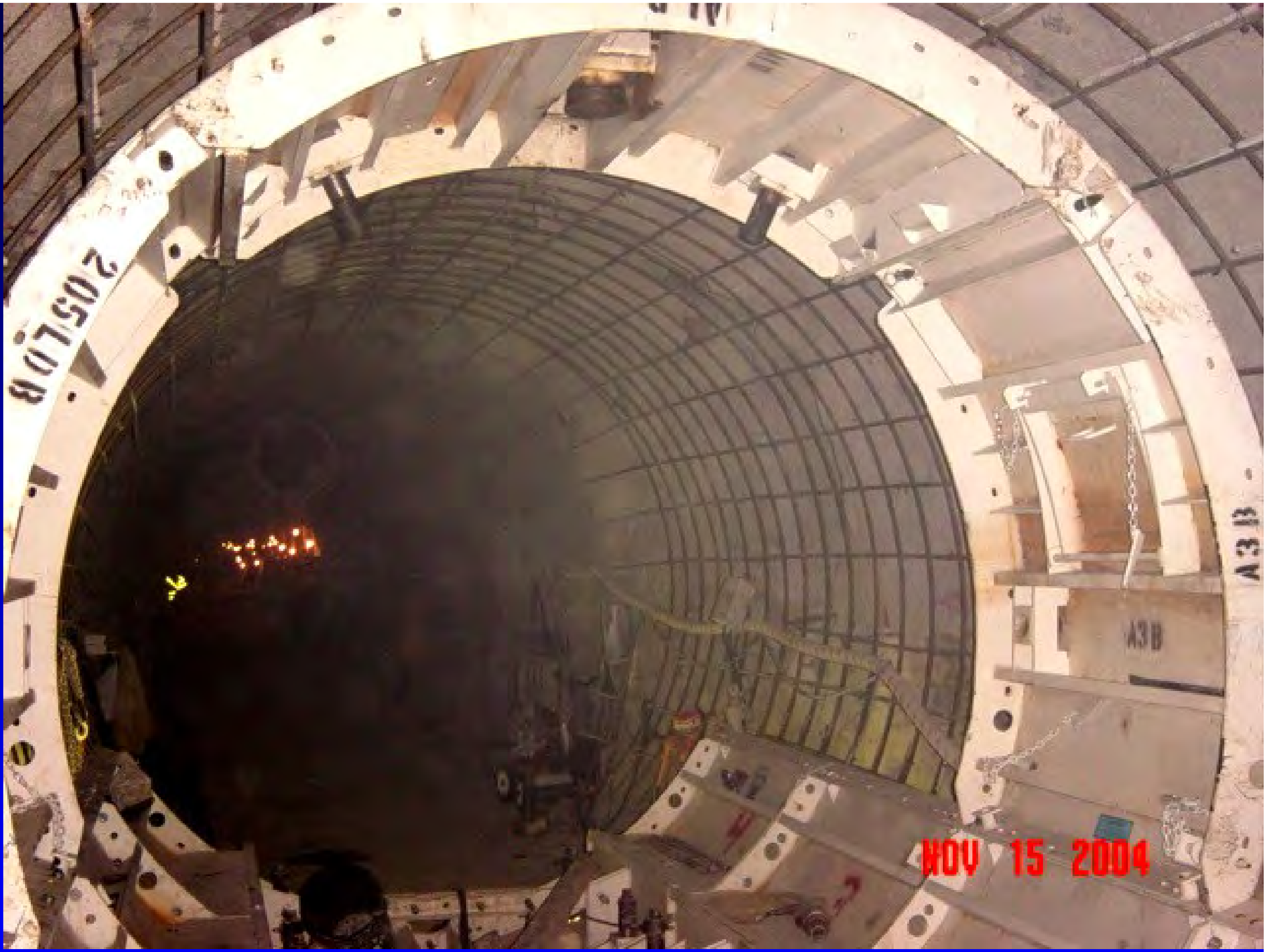

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Window in Forms for Concrete Placement

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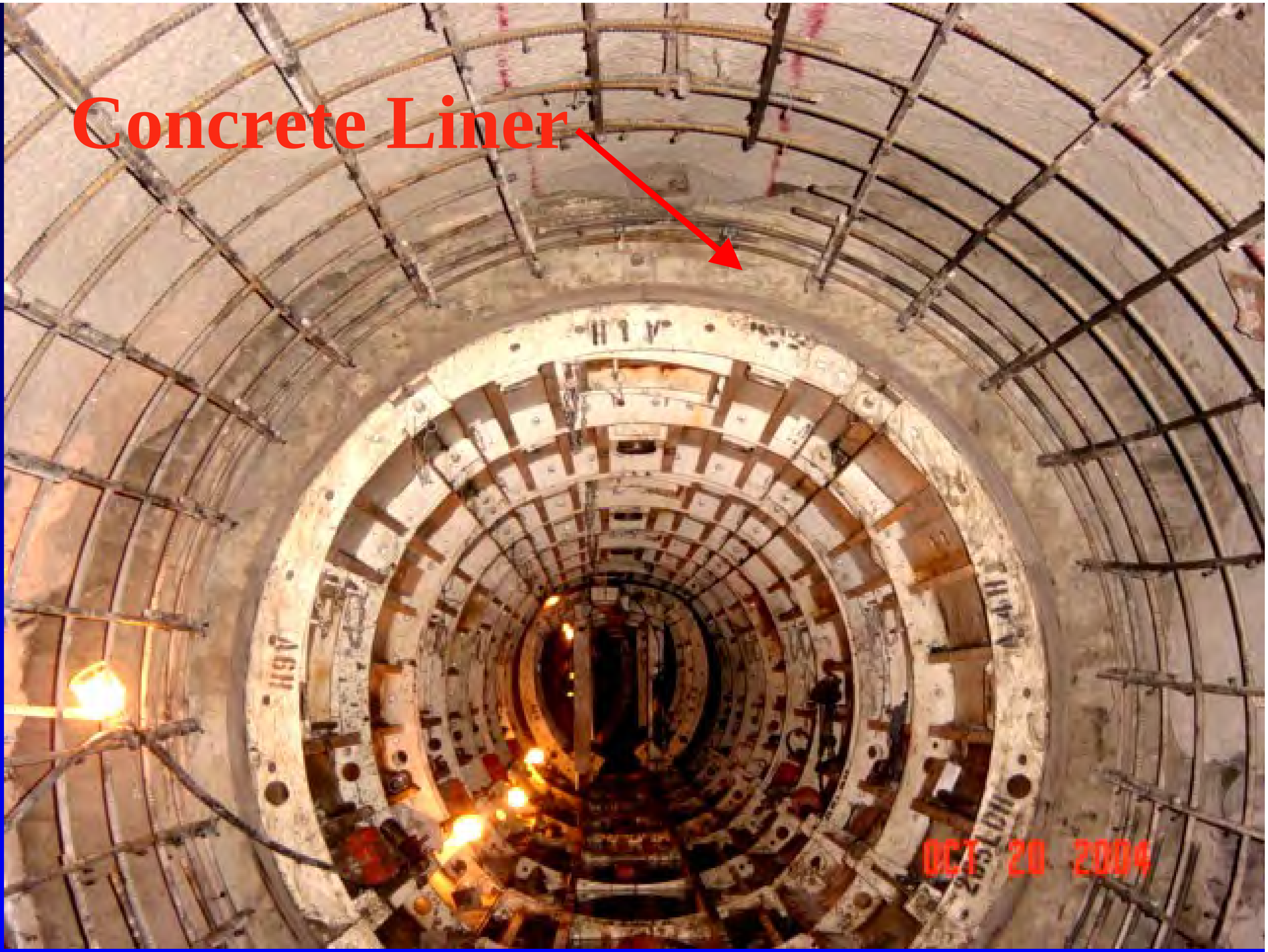

Tunnel Lining Formwork

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Design of Concrete Bifurcations

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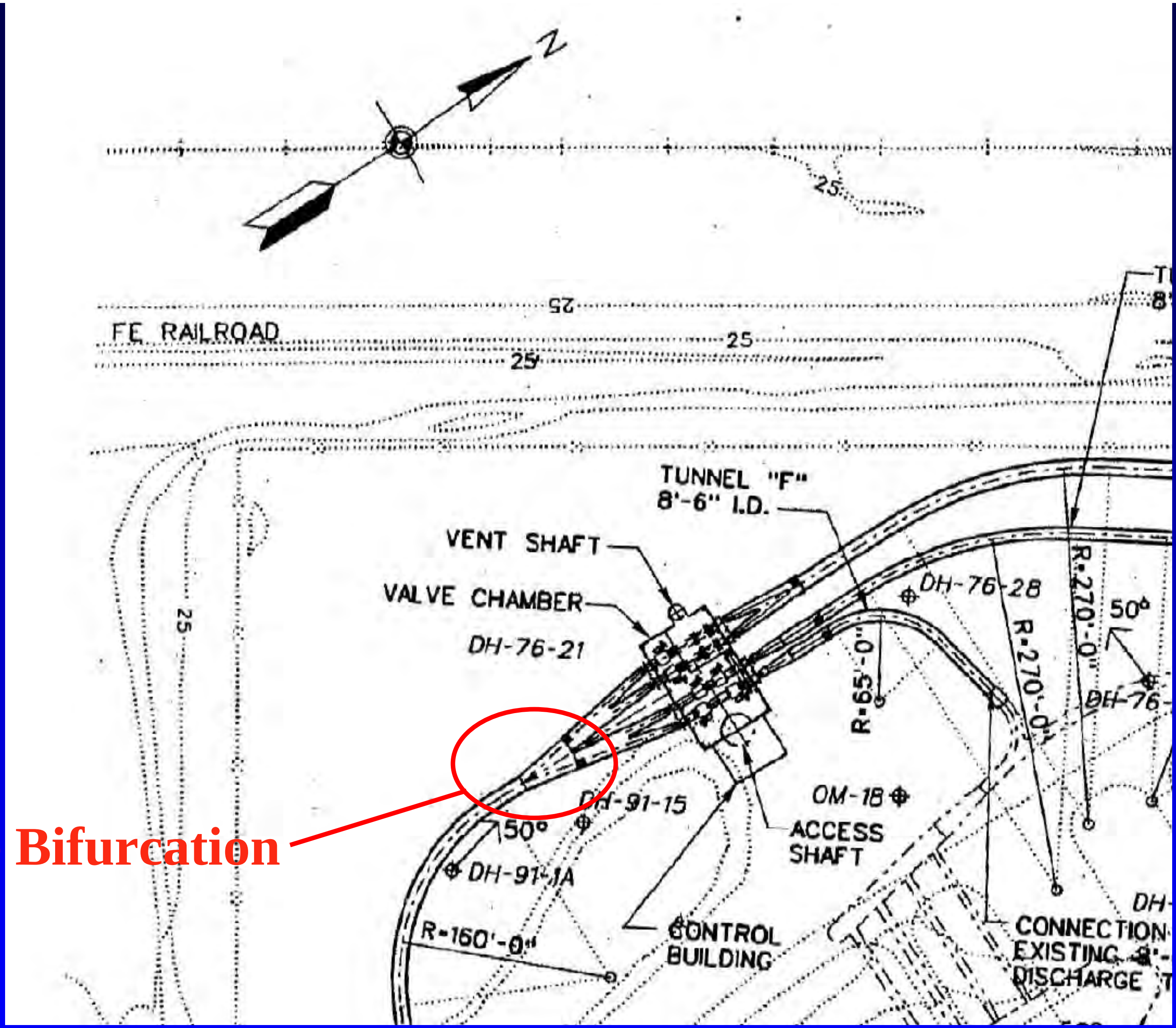

Concrete Bifurcation

Plan - Concrete Bifurcation

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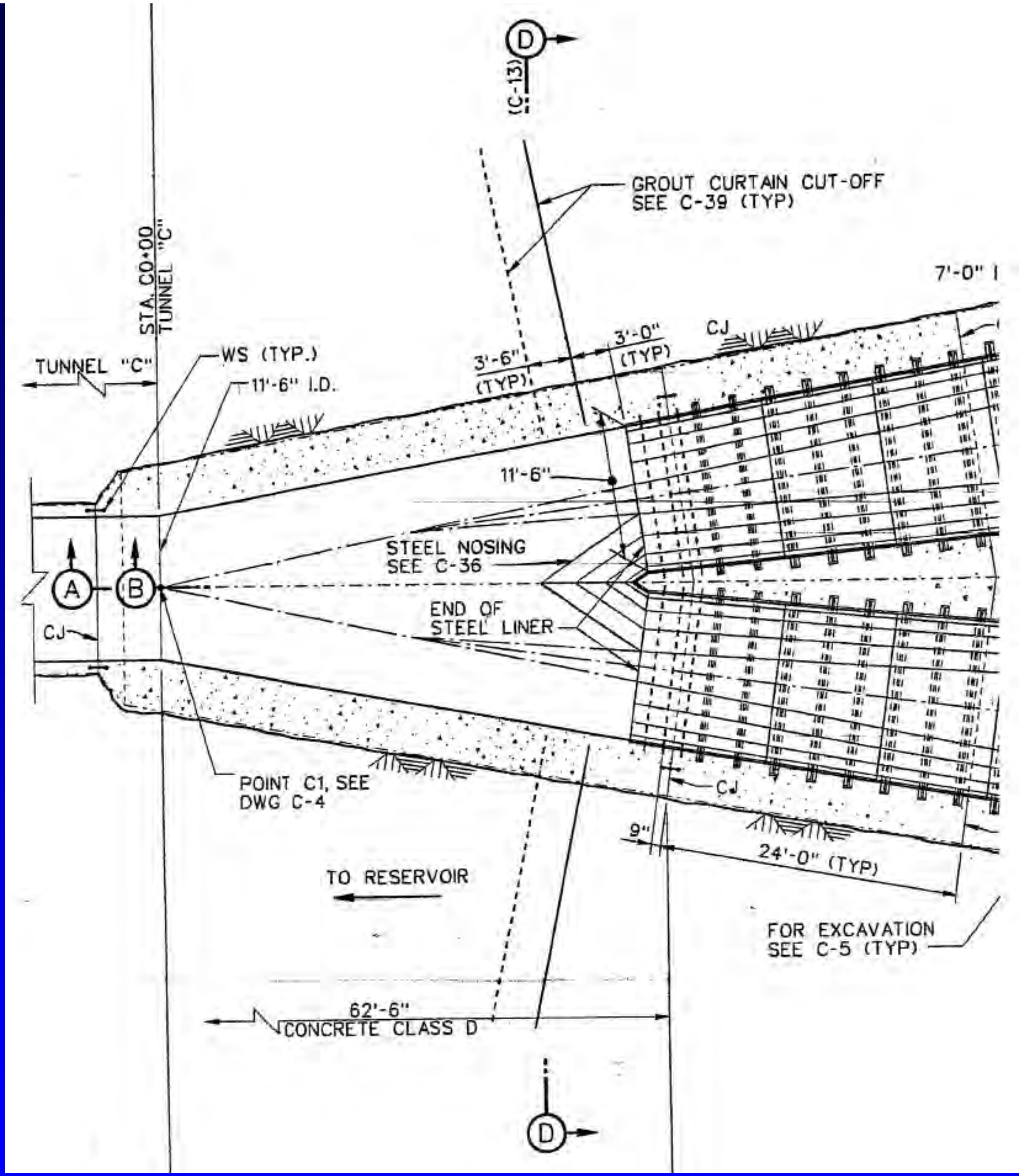

Plan of Concrete Bifurcation

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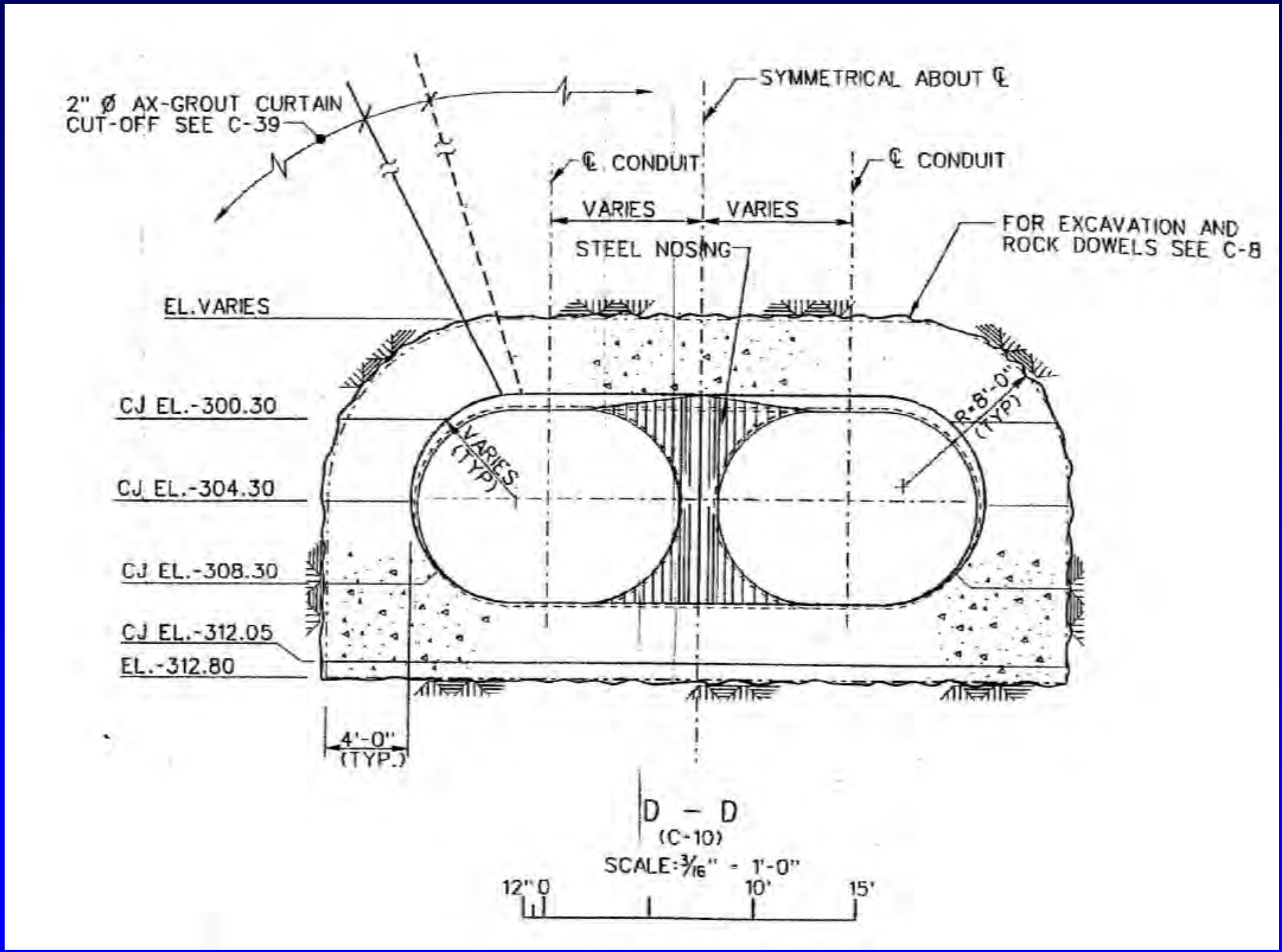

Hydraulic Design Consideration

- Concrete Bifurcation is subjected to moderate turbulence - 10,000 psi concrete

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External Pressure Design

- Designed for external pressure of 136 psi
- External Pressures are resisted by the use of rock anchors on all sides
  - necessary due to non-circular shape
- Concrete sections are designed per ACI 318.

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Internal Pressure Design

- Designed for internal pressure of 160 psi
- SAP 2000 was used for the Analyses to include the effects of the surrounding rock mass. Similar to tunnel design.
- Concrete designed for watertightness and allowable crack width of .008 inches

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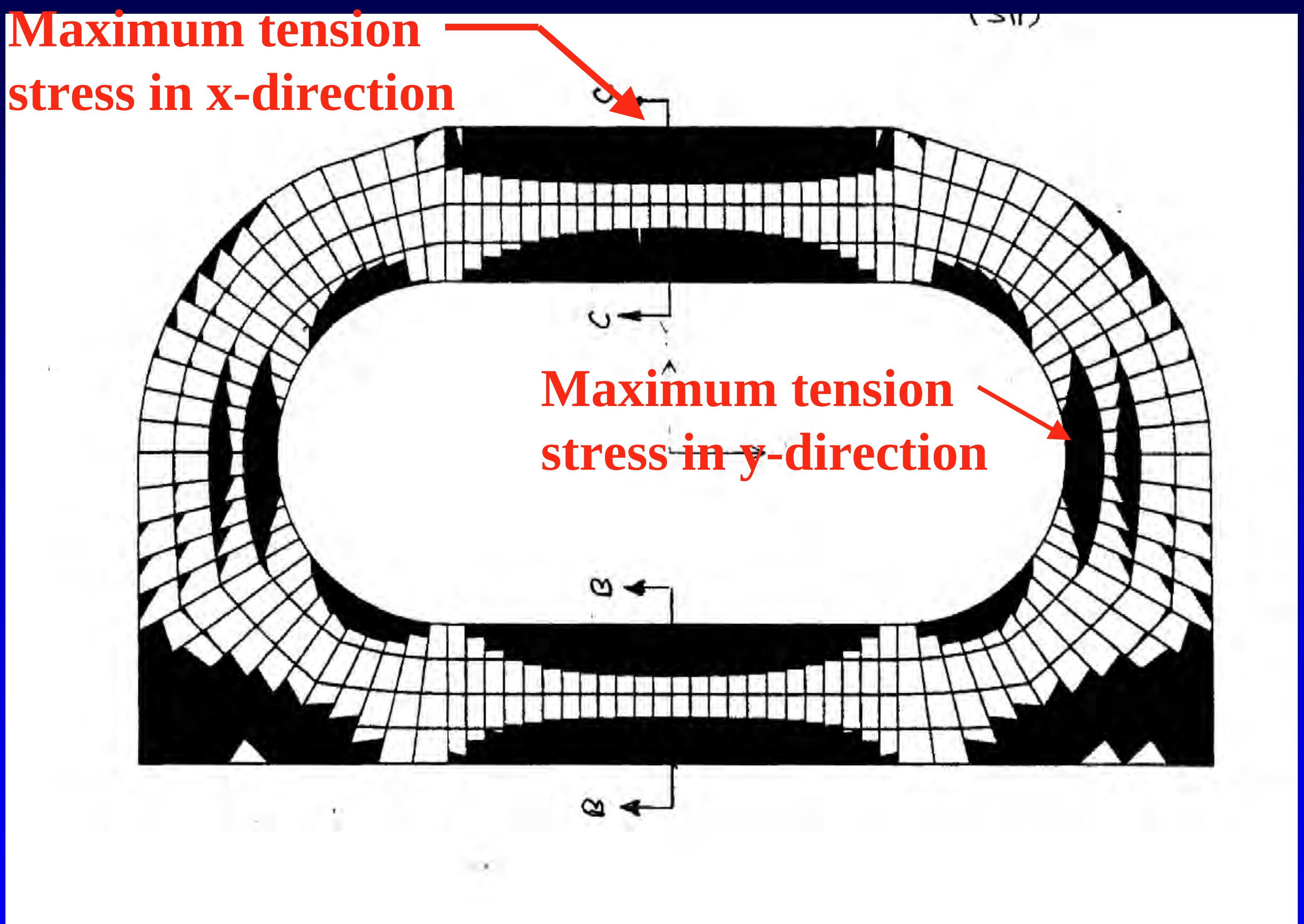

Maximum Stresses – (Internal Pressure)

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Overview of Steel Liner Design

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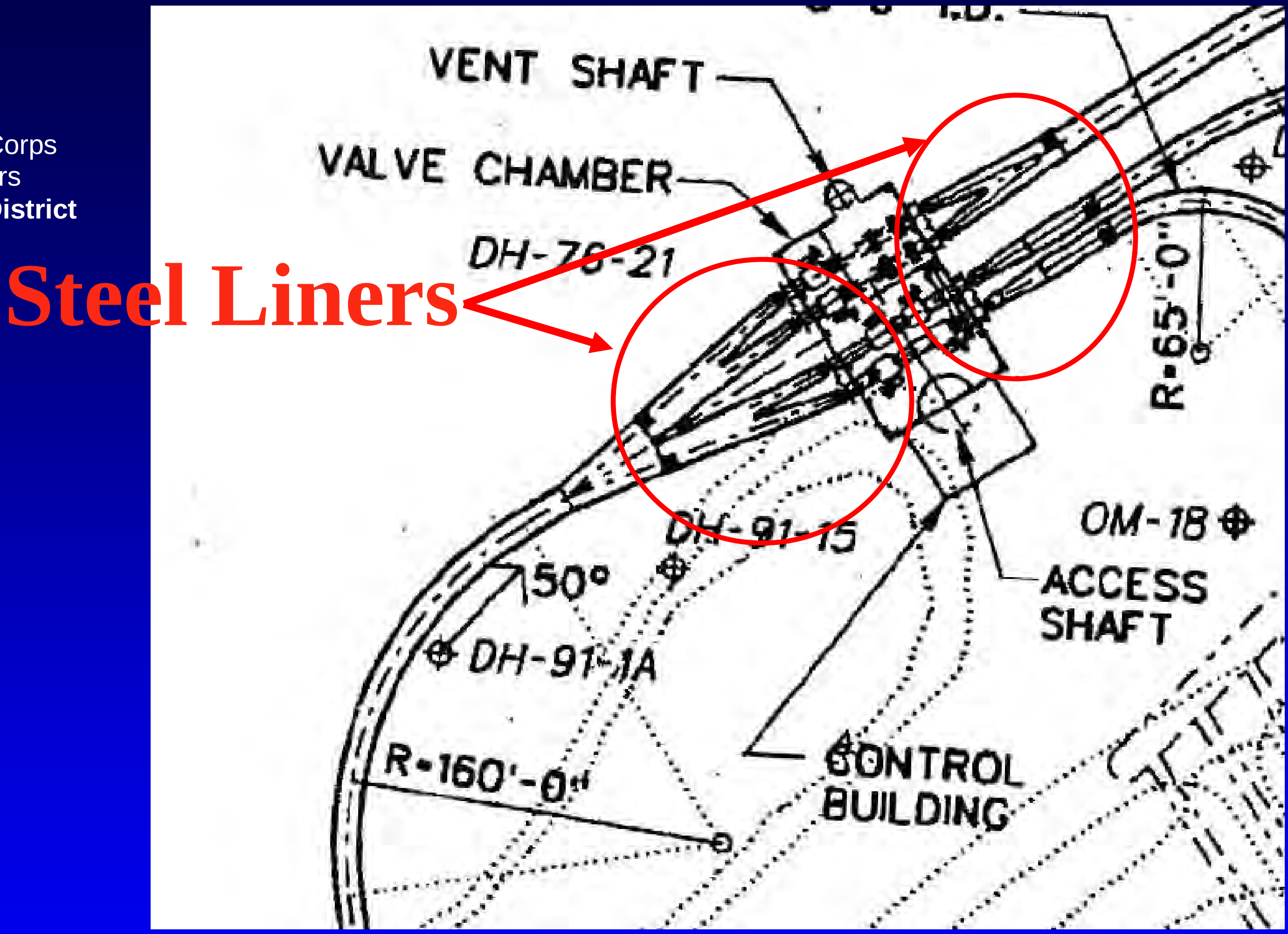

Steel Liners Located at Distribution Chamber

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Purpose of Steel Liners

- Provide erosion protection in areas around Distribution Chamber

  - Velocities > 100 fps

- Form the bifurcation geometry

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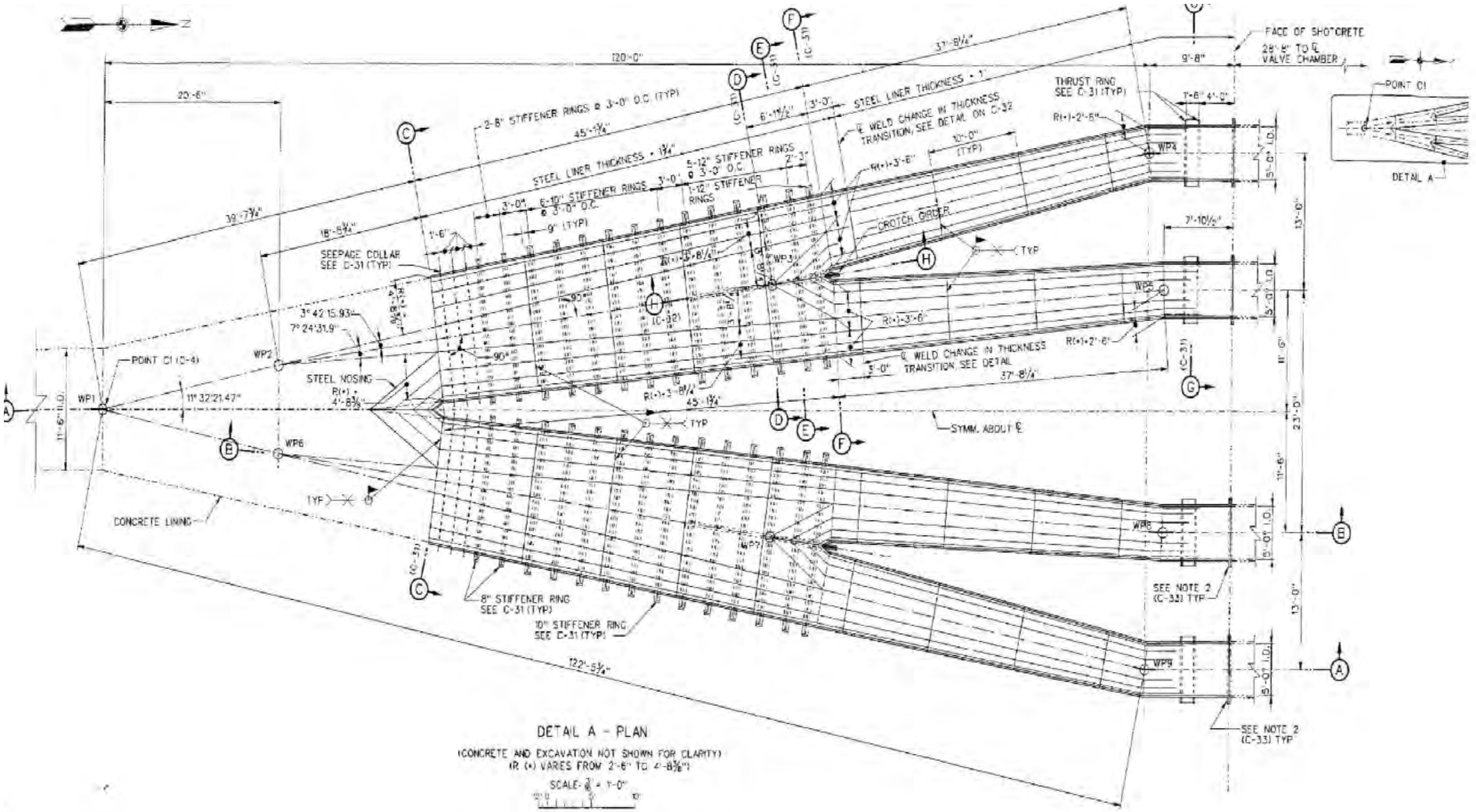
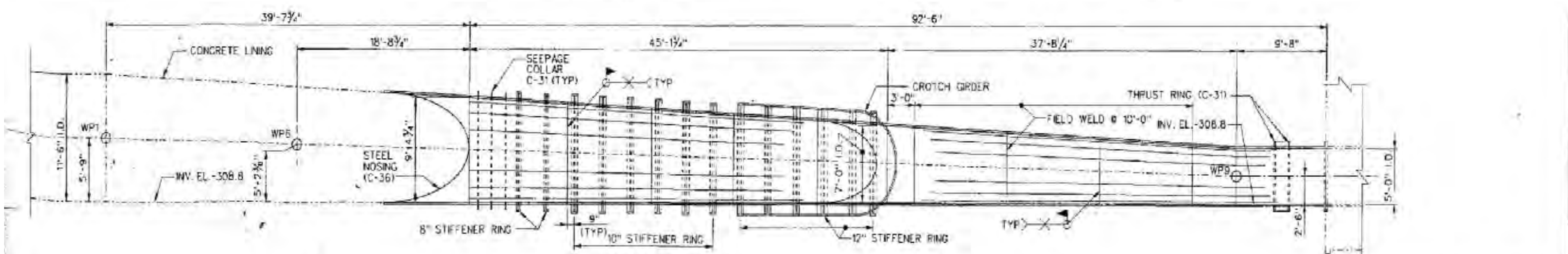
Design of Steel Liners

- Designed for internal and external pressures
- Circular Section designed per EM 2901 Section 9-5d.
- ASME Pressure Vessel Code, Section VIII used for design of noncircular sections
- Stiffeners are provided on obround liner sections to resist buckling
- In areas of geometric discontinuities, 3-D STAAD Model used to design the cross sections.



DETAIL A - PLAN
(CONCRETE AND EXCAVATION NOT SHOWN FOR CLARITY)
(R (+) VARIES FROM 2'-6" TO 4'-8⅜")
SCALE: ⅜" = 1'-0"



A - A

REFERENCE DRAWINGS:

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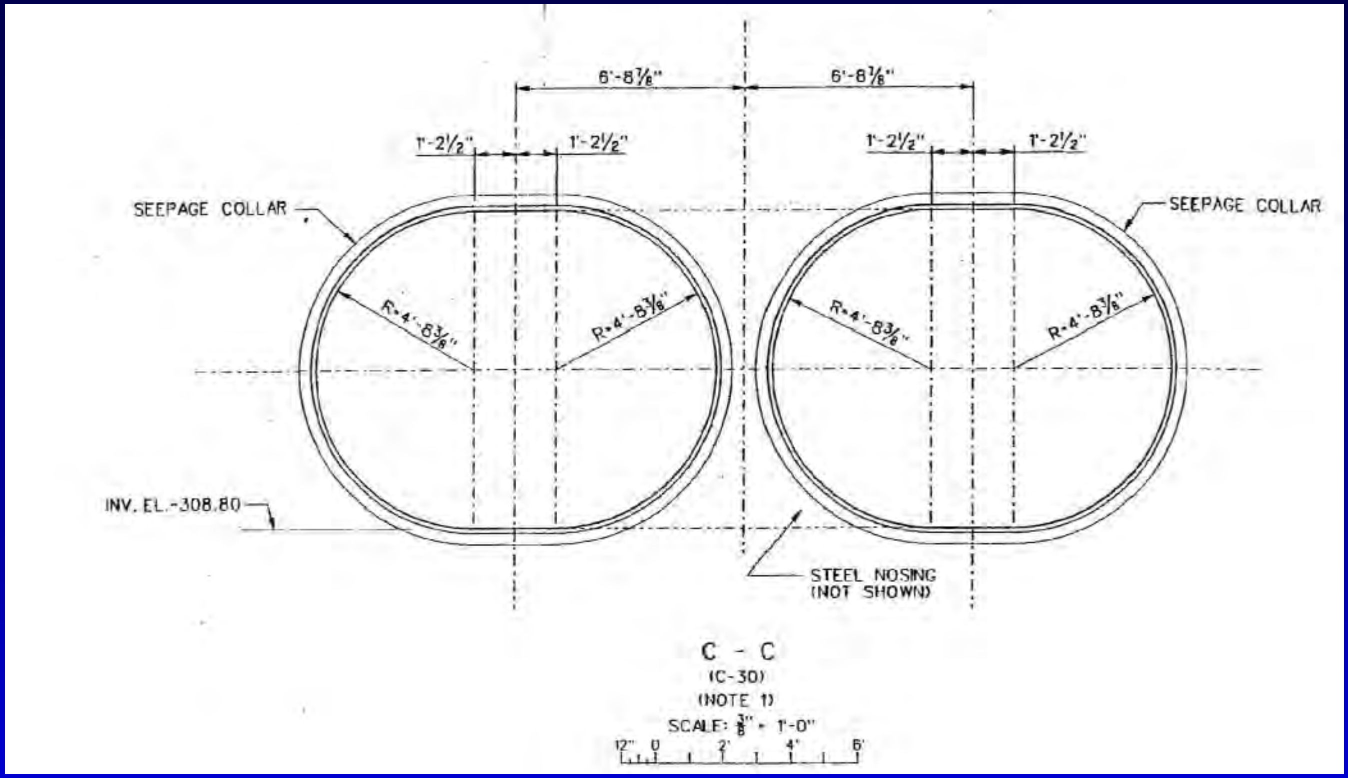

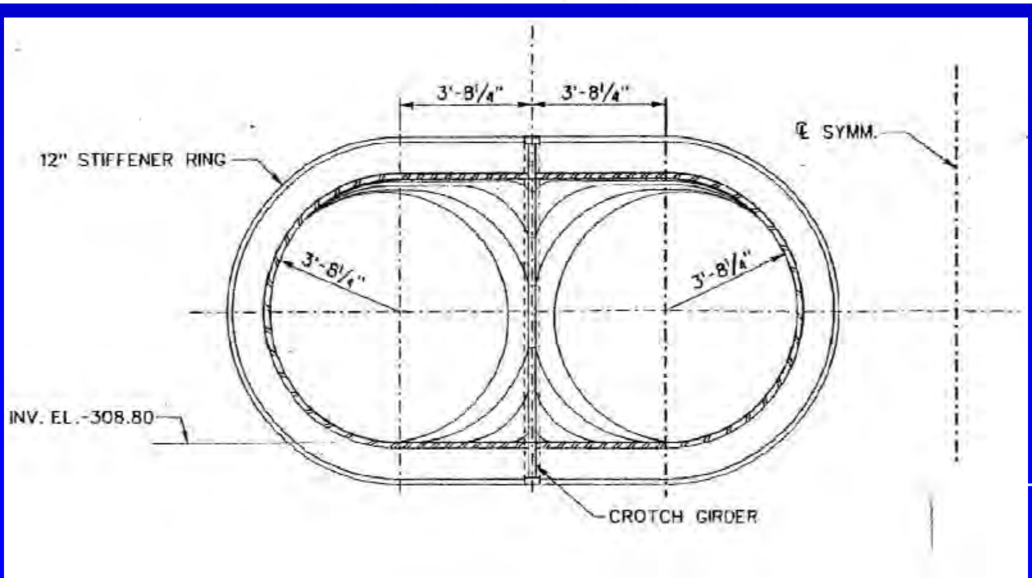

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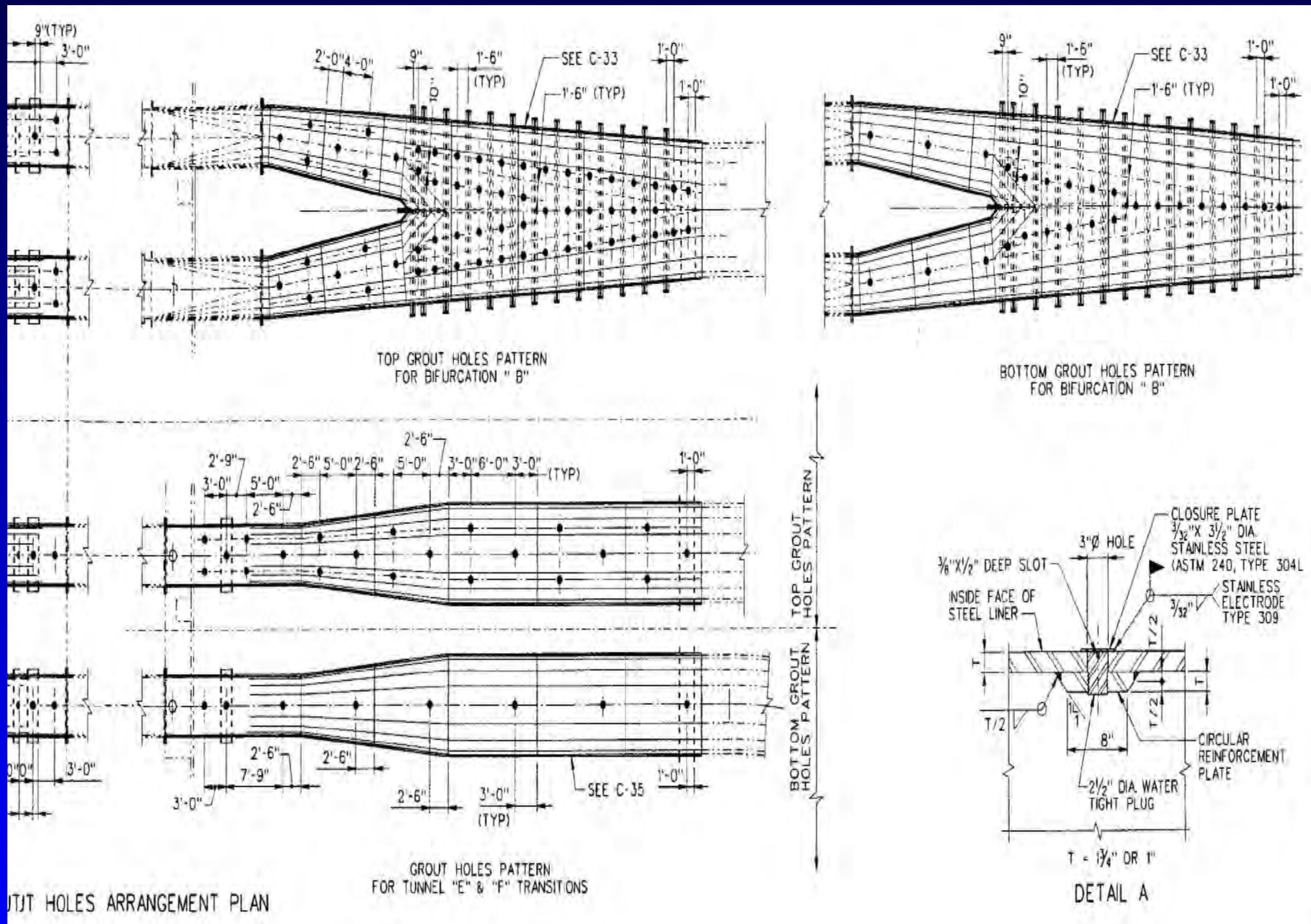

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Steel Nosing being lowered into 26' dia. Access shaft

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View From Inside Steel Liner

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Steel Liner Being Welded – Oblong Section

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Positioning Steel Nosing

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Thank You

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Machine-bored Tunnel
(the new way)

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Intersection of Machine-bored Tunnels

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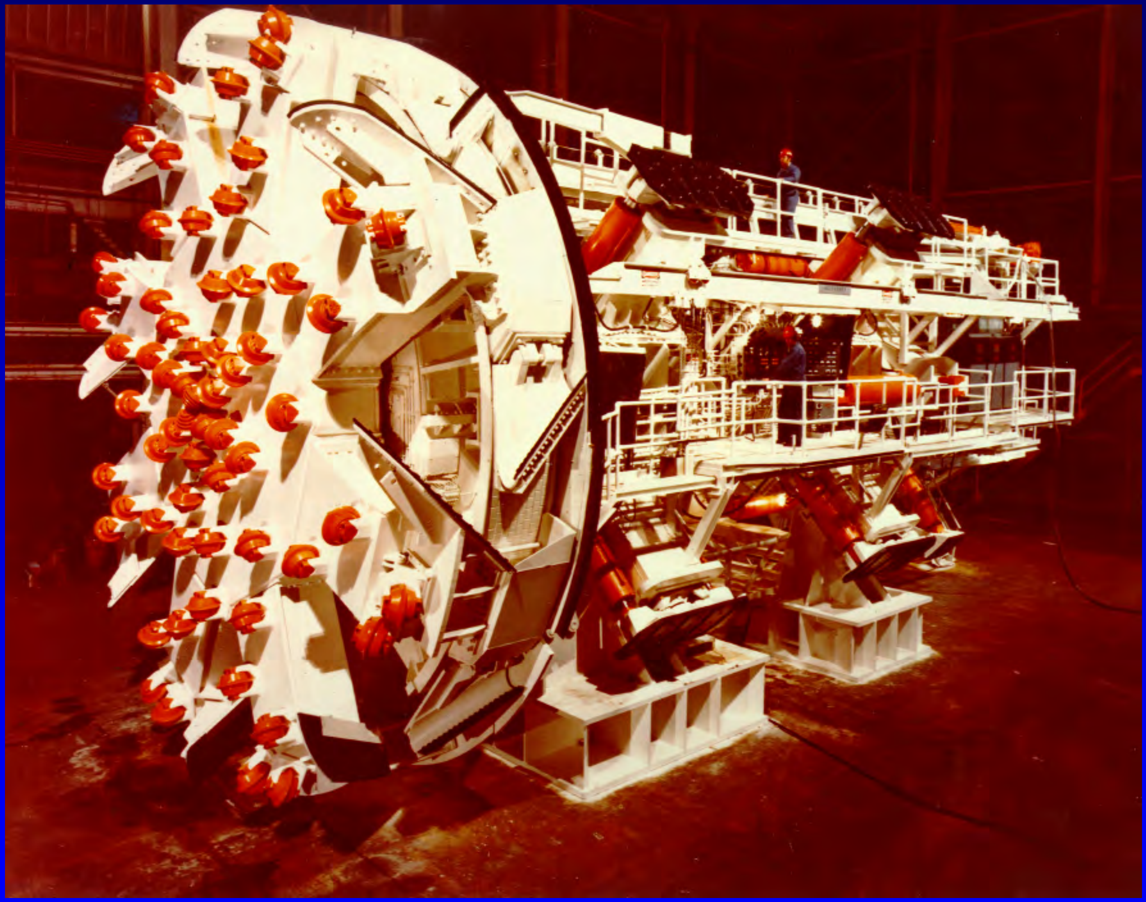
TUNNEL BORING MACHINE



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27-ft Diameter Machine-bored Tunnel – Before Lining

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Placing Concrete for Tunnel Lining

LINED TUNNEL

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Chicago District

Unified Facilities Criteria: Seismic Design for Buildings

(UFC 3-310-04)

2005 Infrastructure Systems Conference

Track 14, Session 14C
Wednesday 3 August 2005

Presented by Jack Hayes, CEERD CERL, Champaign, IL

Presentation Outline

- Brief history
- Today's focus and philosophy
- Approach to document development
- Major features (de facto document outline)
- Training & future directions
- Q & A (*time-permitting*)

Brief (Rich) History

- **Tri-Services developed comprehensive seismic design criteria long before national model codes did (only the UBC and its predecessors were close), e.g.:**
  - **TM 5-809-10/NAVFAC P-355/AFM 88-3 Ch 13 (1982, 1992)**
  - **TM 5-809-10-1/NAVFAC P-355.1/AFM 88-3 Ch 13 Sec A (1986)**
  - **TM 5-809-10-2/NAVFAC P-355.2/AFM 88-3 Ch 13 Sec B (1988)**
  - **TI 809-04 (1998)**
  - **TI 809-05 (1999)**
  - **TI 809-07 (1998)**
- **Pioneers: Sig Freeman (*WJE*), Joe Nicoletti (*URS*) , Jim Tanouye, Ralph Strom & Ray Decker (*USACE*)**

Brief History (Continued)

- Evolution of FEMA's NEHRP "recommended provisions" in 1990's and beyond led to including more comprehensive seismic design guidelines in ASCE 7, and thence in the IBC.
- Tri-Services, via UFC 1-200-01, have mandated maximum reliance on the IBC as the national model code (IBC adopts ASCE 7 & all material codes, e.g. ACI 318).
- Funding for DoD criteria development continues to shrink.

Focus & Philosophy

- Incorporate provisions of 2003 *International Building Code* (IBC) by reference, to maximum extent possible.
  - ∴ Adopt ASCE 7-02 and material-specific codes (e.g. ACI 318-02) by reference, to maximum extent possible.
- Provide DoD-unique criteria and guidance where necessary & appropriate.
- "Look ahead" in a few places and adopt ASCE 7-05 provisions, if they provide some advantage over ASCE 7-02 provisions (ASCE 7-05 is currently under ballot and seismic provisions will be adopted almost *in toto* by 2006 IBC).

Approach to Document Development (1)

- Tri-Service Structural Discipline Working Group (SDWG) oversees development – Caulder (AF), Hewitt (NAVFAC), Rossbach (USACE).
- UFC is primarily developed by CEERD CERL (Hayes, Sweeney, Wilcoski).
- OCONUS seismicity data are developed by USGS (Leyendecker).
- Tri-Service technical review is provided by SDWG, CENWK (Wright, Sivakumar), CENPD (Petersen), & CEHNC (Grant).

Approach to Document Development (2)

- Outside mentoring & peer review are provided by:
  - Bob Bachman (Chair, ASCE 7 Seismic Task Committee)
  - Ron Hamburger (Chair, BSSC Provisions Update Committee - PUC)
  - Jim Harris (Chair, ASCE 7)
  - Bill Holmes (Past Chair, BSSC PUC)
  - Harold Sprague (Member ASCE 7, BSSC PUC)
  - EV Leyendecker (USGS, Member ASCE 7, BSSC PUC)

Approach to Document Development (3)

- Replace TI 809-04 and TI 809-05 with UFC 3-310-04.
- Retain unique guidance features of TI 809-04 in updated form (diaphragms, architectural / mechanical / electrical components, masonry (passed to masonry UFC), & flow charts / reference tables.
- Review each section/paragraph of 2003 IBC and determine if it could be used as written or needed modification.
- Transfer CONUS & OCONUS seismicity data (spectral accelerations, not zones) to UFC 3-310-01 (25 May 05).

Major Features (1)

- UFC directs designers to use provisions of 2003 IBC, except where changes are required. This is covered by Appendix B of the UFC and will apply to conventional DoD buildings. "Default" values are to use IBC provisions. Where changes are required, designer is told to:
  - Add a new section to the IBC provisions;
  - Delete the referenced IBC section;
  - Replace the referenced IBC section with new provision; or,
  - Supplement the referenced IBC section with additional information.

Major Features (2)

- Appendices B, D, & E direct designers to UFC 3-310-01 for spectral acceleration data, including OCONUS data.
- Appendix B creates new DoD-unique Seismic Use Group (SUG) IV, for nationally strategic military assets (e.g. NMD).
- Appendix B addresses existing buildings via reference to ASCE 31-03 (evaluation) & FEMA 356 (rehabilitation).
- Appendix C substitutes a new optional "simplified" design procedure for regular, low-rise buildings. This replaces "simplified analysis" provisions of 2003 IBC (§ 1616.6.1) with a new procedure that will be in ASCE 7-05. Many DoD buildings should fall into this category.

Major Features (3)

- Appendix D provides designers with an optional, alternate design procedure for buildings in SUG III (UFC does not have SUG IIIE and IIIH of TI 809-04):
  - Specifies nonlinear analysis (static or dynamic) for two performance levels: Life Safety at 2%/50, or MCE; and, Immediate Occupancy at 10%/50, or SE;
  - Adopts acceptance criteria from FEMA 356 for LS and IO performance objectives; and,
  - Somewhat restricts use of seismic force-resisting systems to those that are considered to be "good performers" in earthquakes.

Major Features (4)

- Appendix E provides design procedure for SUG IV buildings:
  - Requires buildings to remain elastic and all critical installed equipment to remain operational at MCE (2%/50 yrs) ground motion;
  - Adds vertical motion component to design & provides method of deriving vertical spectrum from horizontal spectrum (from USGS);
  - Further restricts use of structural systems;
  - Encourages use of supplemental energy dissipation and base isolation in appropriate situations; and,
  - Requires formal peer review.

Major Features (5)

- Appendix F provides guidance for design of architectural, mechanical, & electrical systems:
  - Includes details for ceilings, piping, non-structural walls (based largely on guidance found in TI 809-04); and,
  - Includes certification / testing procedures for equipment, with sample reports.

Major Features (6)

- **Appendix G provides design process flow charts and cross-reference tables that relate UFC provisions to 2003 IBC and ASCE 7-02 provisions (emulates TI 809-04).**
- **Appendix H provides guidance on diaphragm analysis & design (emulates TI 809-04).**
- **Note: TI 809-04 guidance on masonry design is transferred to masonry UFC 3-310-06 (see Track 14, Session 14D).**
- **Note: TI 809-04 guidance on reinforced concrete & structural steel design is dropped, with references to public sector documents provided in Appendix G.**

Training & Future Directions

- PROSPECT Course 027, *Seismic Design for Buildings*, is planned for 22-26 May 06.
- Revised version of UFC 3-310-04 is planned for ~ FY07:
  - 2006 IBC will delete most seismic provisions and simply adopt ASCE 7-05 (ala NFPA);
  - ASCE 7-05 seismic provisions are completely reformatted from ASCE 7-02;
  - Hopefully, FEMA 356 (*Prestandard and Commentary for the Seismic Rehabilitation of Buildings*) will evolve into ASCE 41-xx;
  - Design provisions for non-building structures are not thorough; and,
  - The UFC will move toward direct inclusion in master structural design UFC (see Track 14, Session 14B).

Questions?

Electronic copy of draft UFC 3-310-04 is available.

<u>Contact:</u>

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CEERD-CF-M

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john.r.hayes@erdc.usace.army.mil

Portugues Dam

RCC Materials Investigation

Portugues Dam
RCC Materials Investigation

- **Outline**
  - Goals
  - Mix Design Parameters
  - Materials
  - Test Program
  - Tests on Laboratory Simulated Lift Joints
  - Conclusions

Portugues Dam
RCC Materials Investigation

- **Goals**
  - Determine behavior/characteristics of potential project materials
  - Determine properties for use in design analysis
  - Determine mix proportions for use in test fill placement(s)
  - Provide information for use in adjusting mixtures during production

Portugues Dam

- **Mix Design Parameters**
  - **Workability**
    - **Vebe Consistency 14 to 20 seconds**
    - **Entrapped Air Content 1.0%**
    - **Coarse aggregate proportions and aggregate grading:**
      - **EM 1110-2-2006, “Roller Compacted Concrete”**
      - **Sand aggregate volume selected to limit segregation**
    - **Fine aggregate content:**
      - **Selected by trial mixes to limit segregation**
  - **Strength**
    - **Compressive Strength Range 3000 to 5000 psi**
    - **Tensile Strength 300 psi +/-**

    (Design based on potential of materials!)
  - **Pozzolan**
    - **Targeted 40% cement replacement by volume based on previous experience and “comfort” level of designers.**

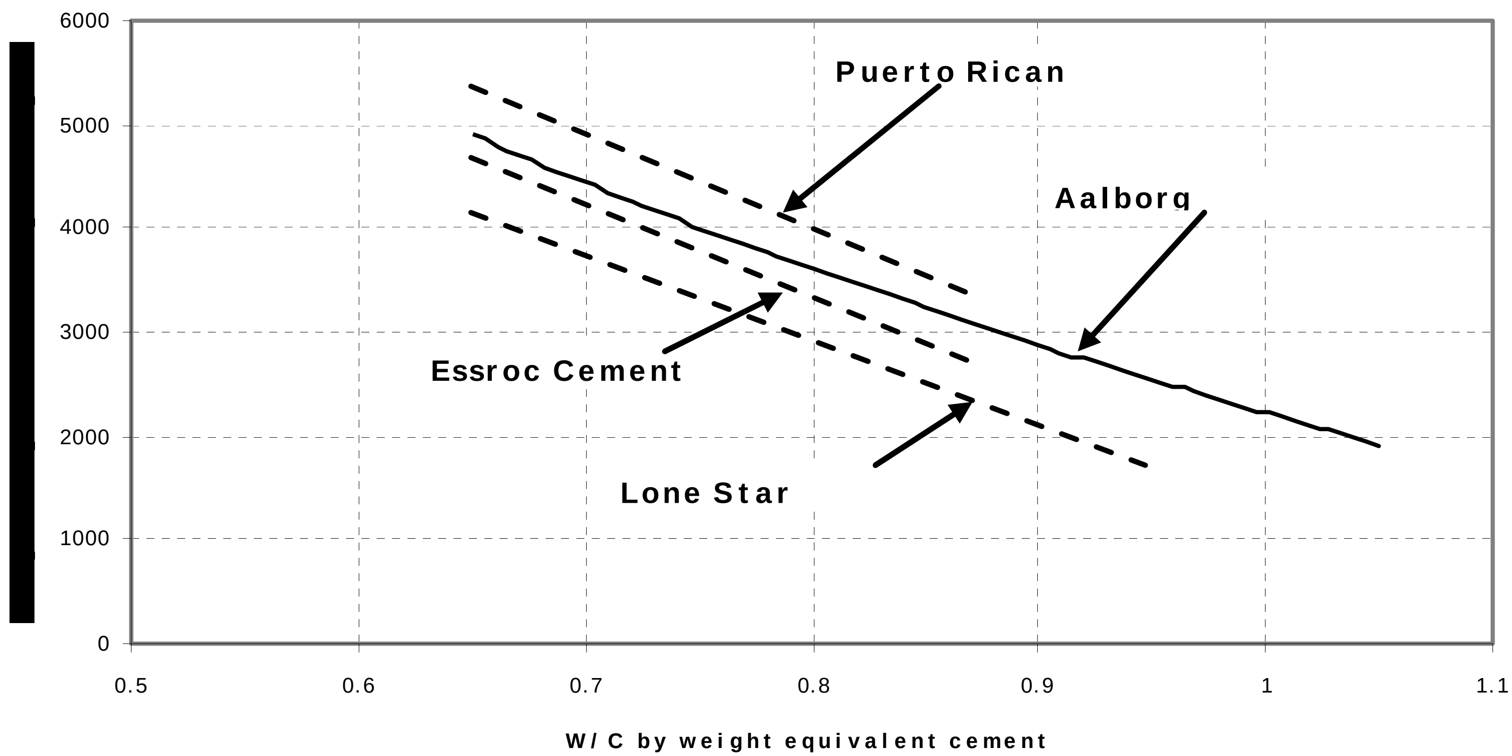
Portugues Dam

- **Materials**
  - **Aggregates: Crushed diorite from government-owned quarry**
  - **Cement:**
    - **San Juan Cement Co., Type I, San Juan**
    - **Puerto Rican Cement Co., Type I, Ponce**
    - **Antilles Cement Co., Type I/II, Aalborg (Denmark)**
    - **Lone Star Cement Co., Type I/II, (Control)**
  - **Pozzolan:**
    - **Dolet Hills, Class F**
    - **Martin Lake, Class F**
  - **Slag:**
    - **Holnam GGBS, Grade 100, Chicago**
  - **Admixtures:**
    - **Master Builders WRA, Pozzolith 220N and 100-XR**

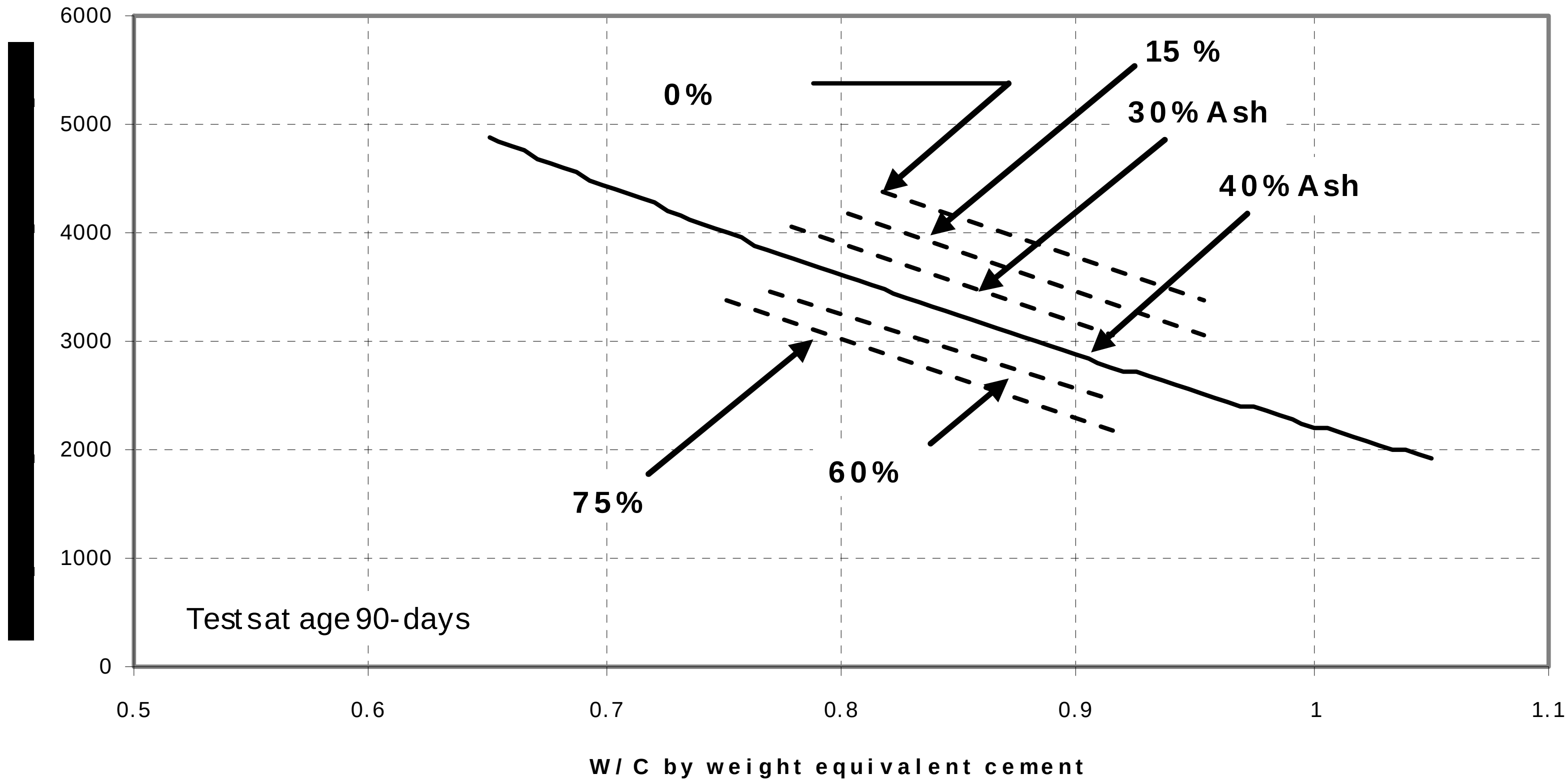
Portugues Dam

- **<u>Materials Investigation Program</u>**
  - **<u>Phase I</u>**
    - **Establish baseline proportions for RCC mixtures**
    - **Proportion series of mixes to span 1-year compressive strength of 2000 to 5000 psi (including modulus of elasticity)**
    - **Proportion series of mixes to evaluate effect of cement and pozzolan type**
    - **Proportion series of mixes to evaluate use of slag**
    - **Proportion series of mixes to investigate effect of pozzolan content**
    - **Proportion series of bedding mortar mixes**
    - **Perform direct tensile strength tests on "jointed" 6x12-inch cylinders**
    - **Select "design" mix**

Compressive Strength vs W/C
(w/40% Dolet Hills Ash)



Compressive Strength vs W/C
(Aalborg Cement with varying Ash %)



Portugues Dam

- **Materials Investigation Program**
  - **Phase I Supplemental**
    - Perform dry rodded unit weight tests to verify coarse aggregate proportions
    - Proportion series of mixes at varying sand contents to verify sand aggregate content
    - Proportion series of mixes to further investigate use of higher pozzolan contents (60 and 75-percent cement replacement by volume)
    - Proportion series of mixes with varying WRA/Retarding admixture dosage to evaluate effect on time of set
    - Perform sand degradation tests to investigate sand balling anomaly
    - Proportion mix with "clean" sand to evaluate effect on compressive strength and workability (water content)
    - Perform "modified" accelerated cure strength tests to evaluate compressive strength gain of high pozzolan content mixes

Portugues Dam

- **<u>Materials Investigation Program</u>**
  - **Phase IIa**
    - **Construct series of panels to investigate direct and splitting tensile strength and biaxial direct shear strength of lift joints**
  - **Phase II**
    - **Modulus of Elasticity and Poisson's Ratio Tests**
    - **Creep and Autogenous Volume Change Tests**
    - **Adiabatic Temperature Rise Tests (Including Q-drum)**
    - **Thermal Diffusivity**
    - **Coefficient of Thermal Expansion**
    - **Specific Heat**
    - **Tensile Strain Capacity**

Portugues Dam
Standard Procedures

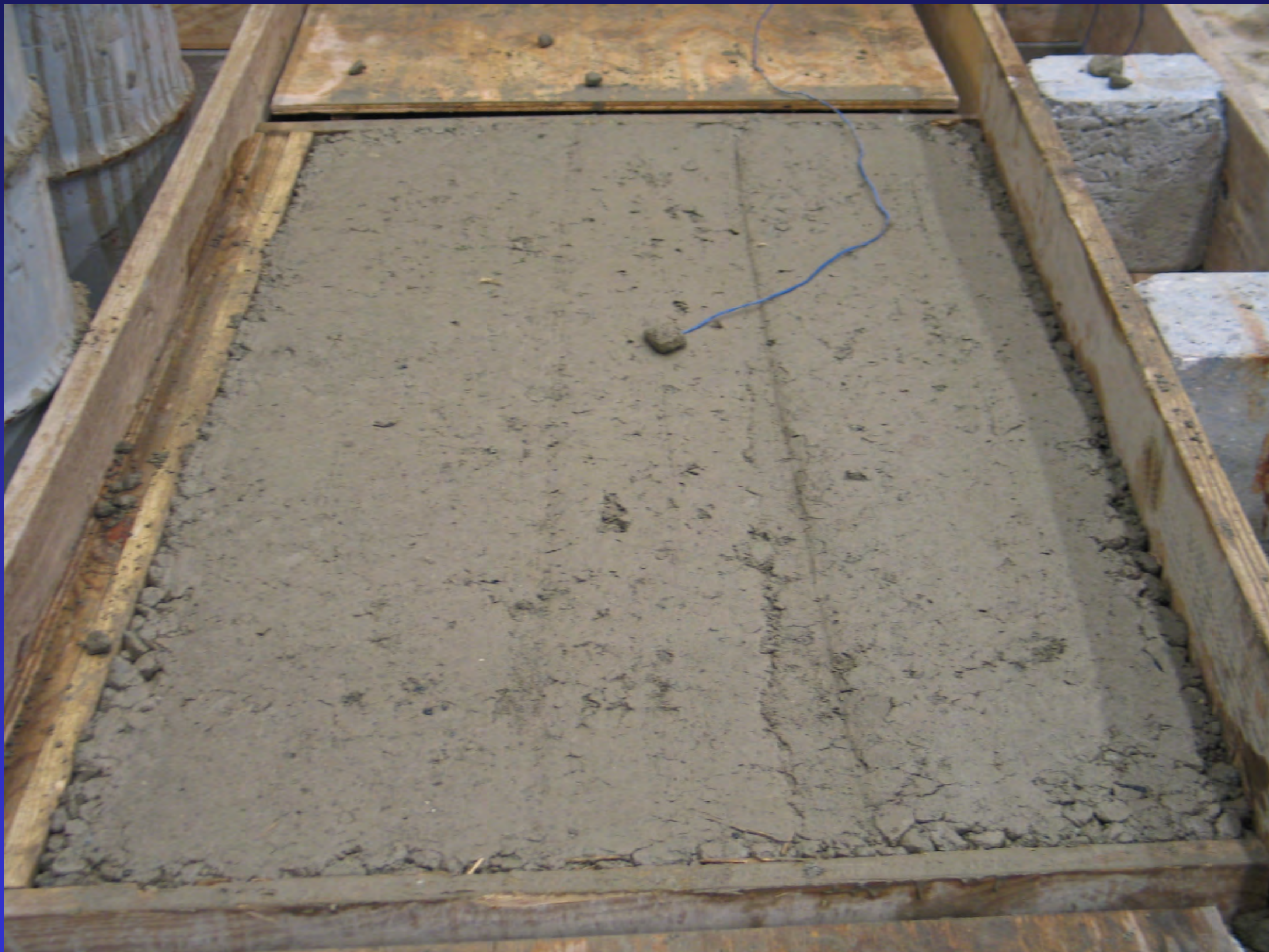

TDR
5.40


#24

Simulated Lift Joints

- Nominal 46 x 72 x 12-inch thick panels
- Constructed in two lifts using varying lift joint treatments
- RCC consolidated using walk-behind vibratory roller
- Core and sawn block samples for direct and in-direct tensile strength, bi-axial direct shear strength
- Results intended for use in evaluating effect of fly ash, retardation, joint maturity, fines content

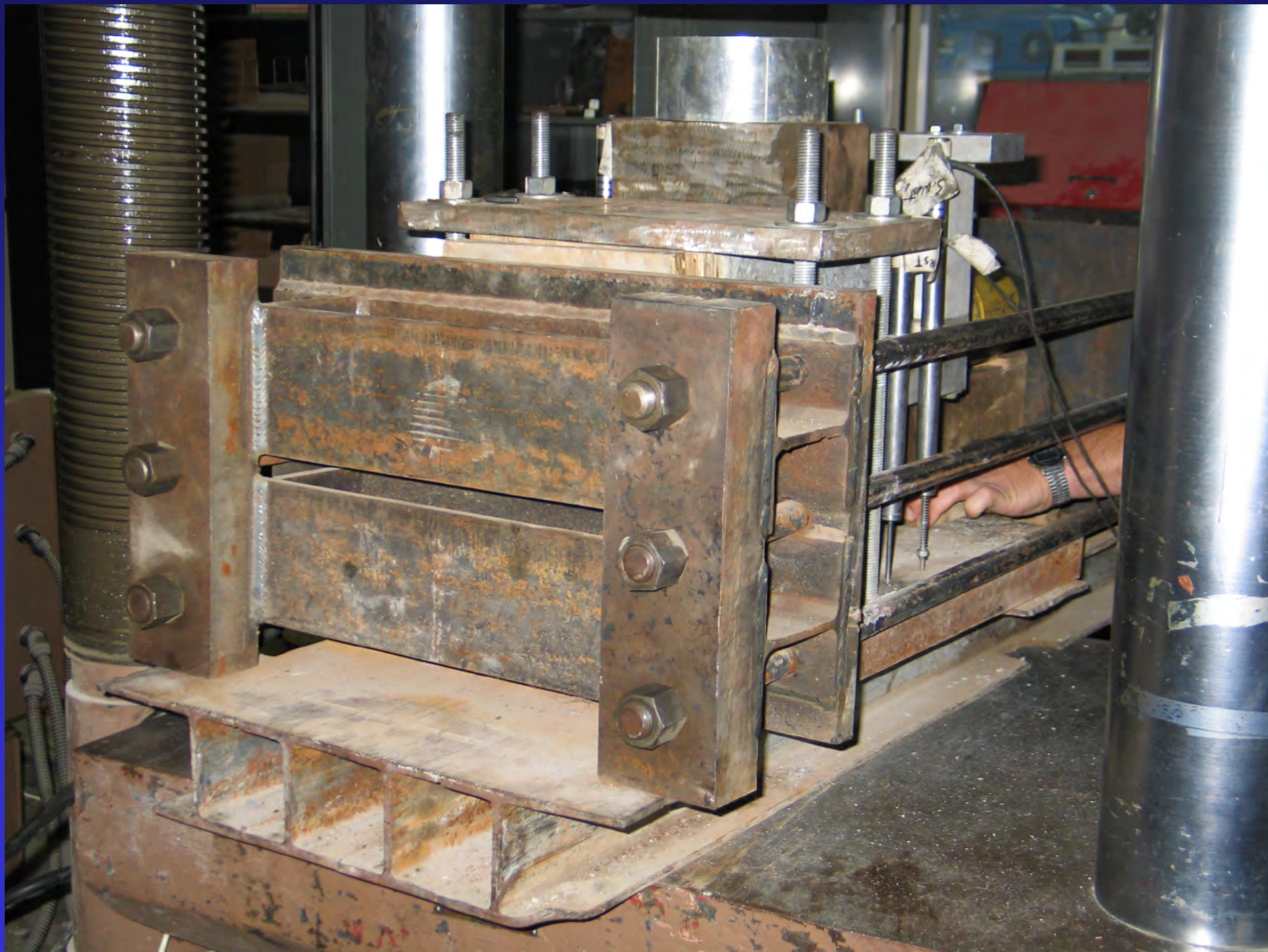

3500PSI

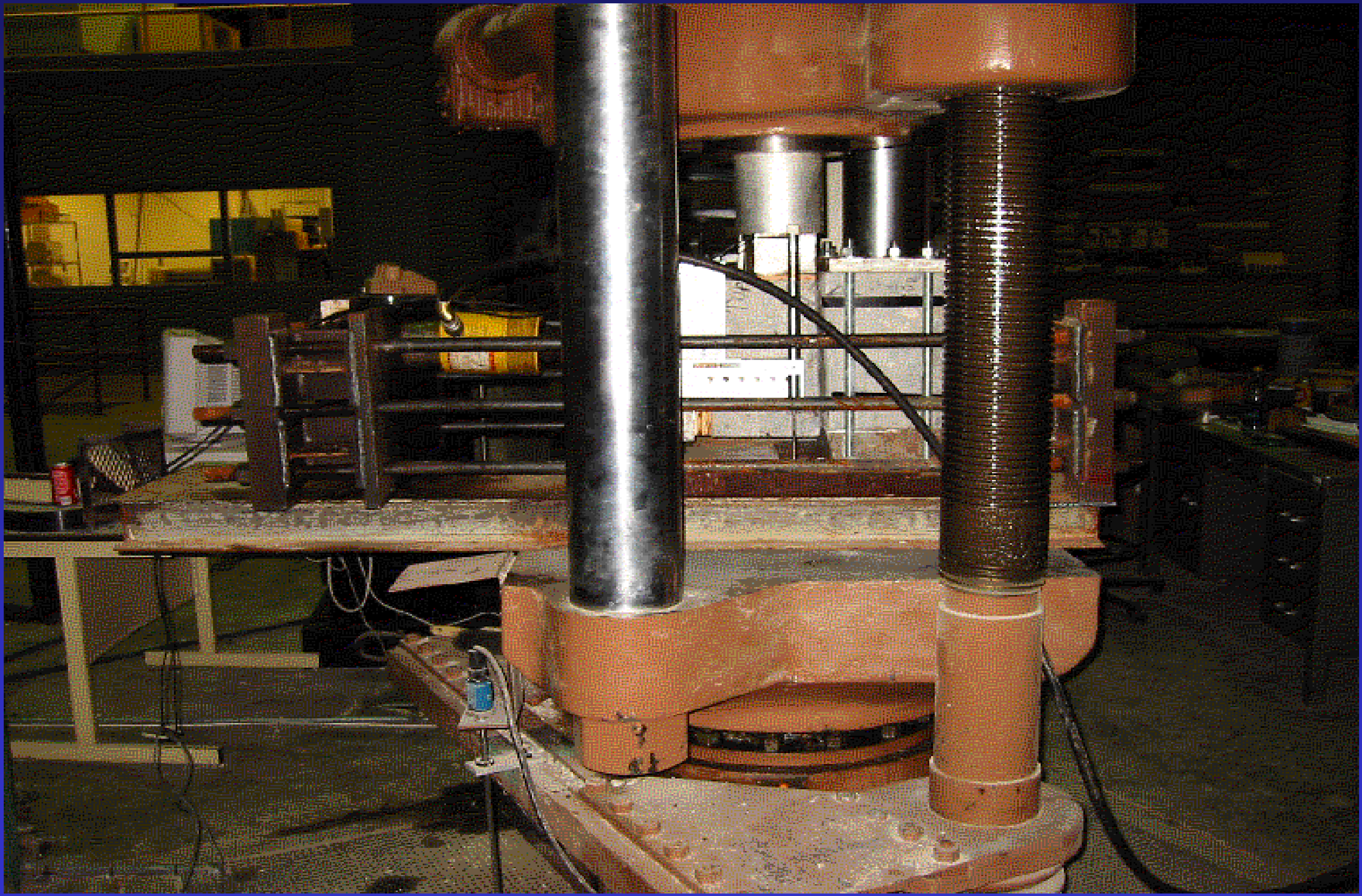



PANEL F
PANEL F
90D-1
PANEL F
365D-1
90D-2
PANEL F

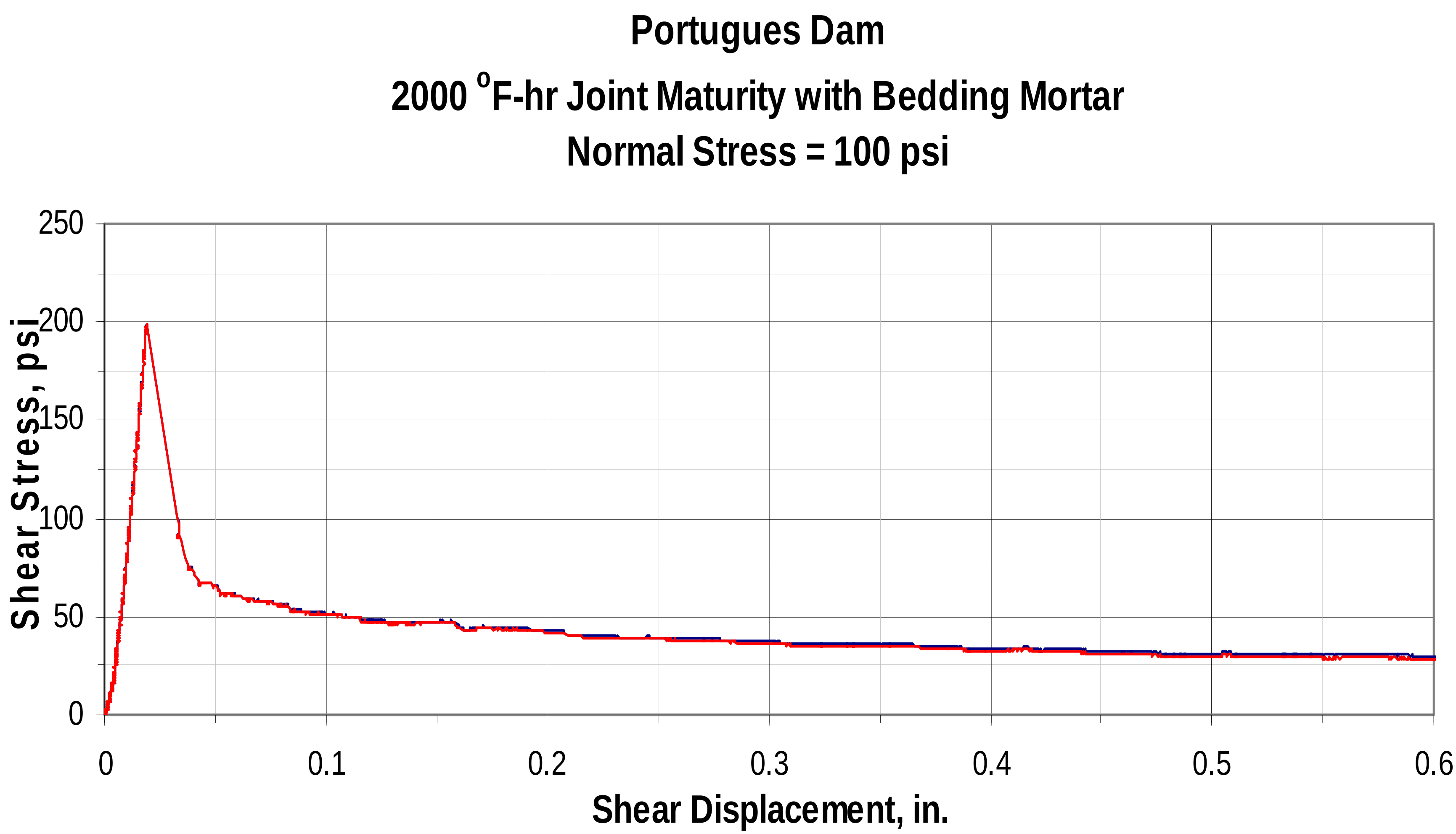

(3)
(2)
28 Day

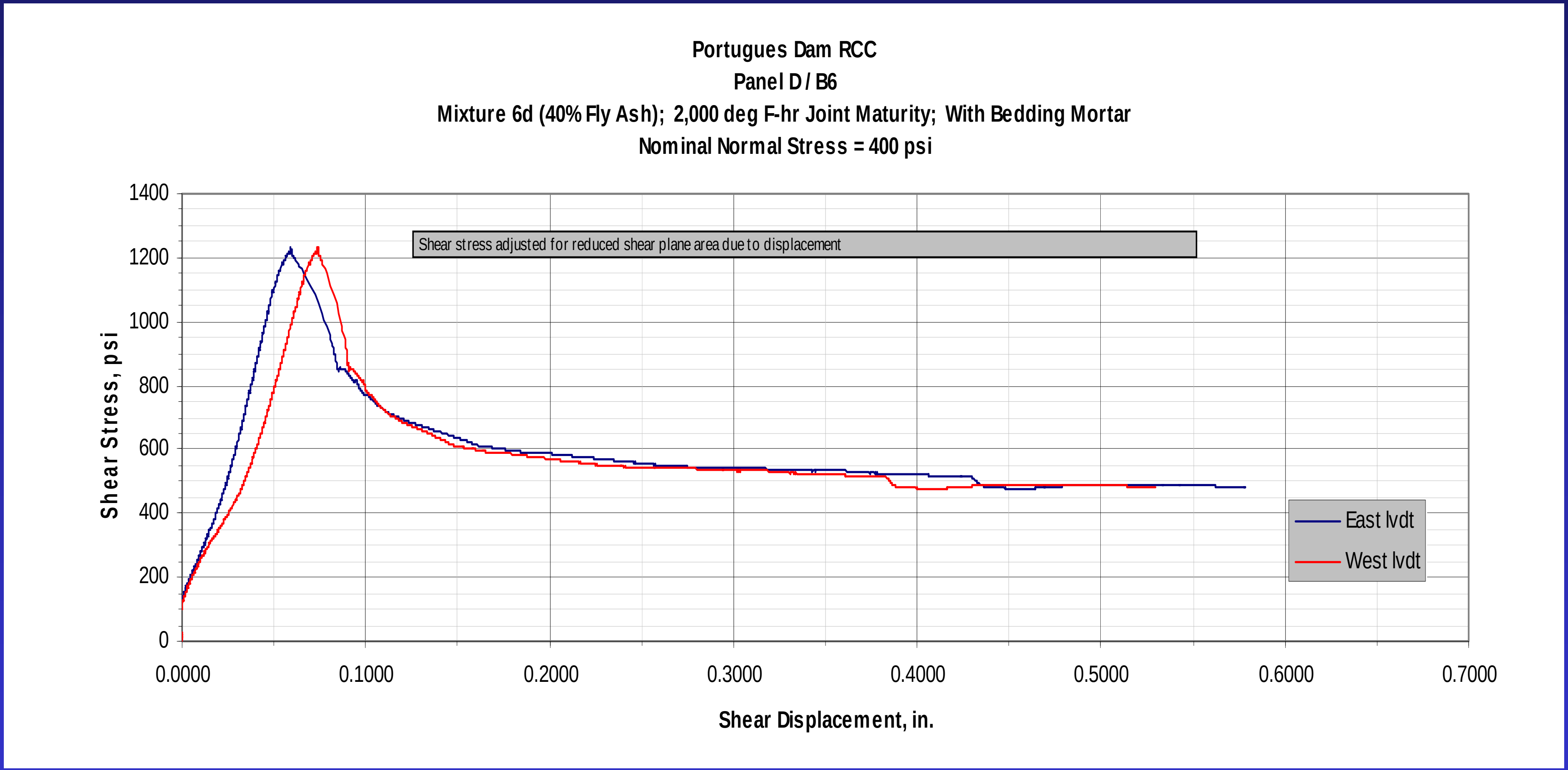

29PD6D-DT-365d-3

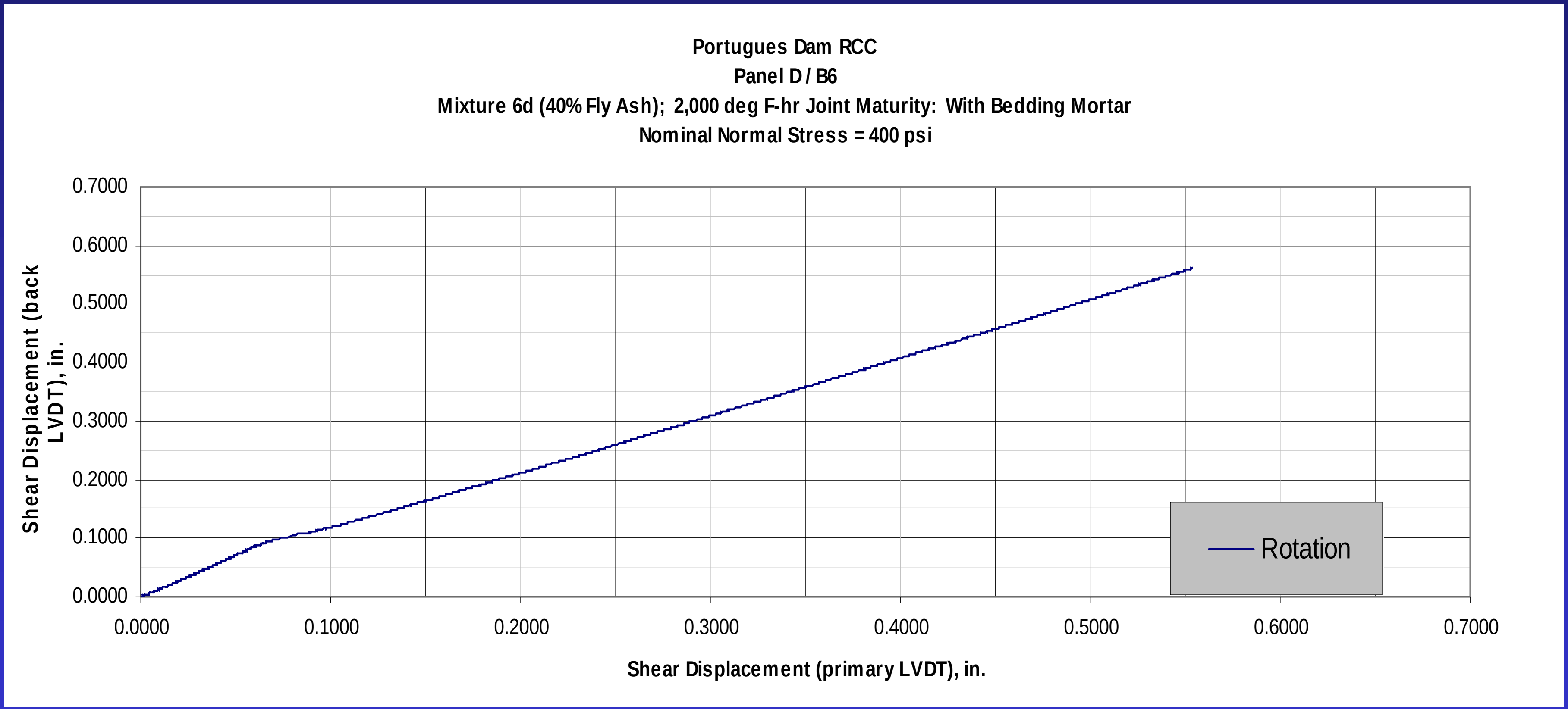





SATEC


Portugues Dam
2000 °F-hr Joint Maturity with Bedding Mortar
Normal Stress = 100 psi
Shear Stress, psi
250
200
150
100
50
0
0
0.1
0.2
0.3
0.4
0.5
0.6
Shear Displacement, in.


Portugues Dam RCC
Panel D / B6
Mixture 6d (40% Fly Ash); 2,000 deg F-hr Joint Maturity; With Bedding Mortar
Nominal Normal Stress = 400 psi
Shear stress adjusted for reduced shear plane area due to displacement
Shear Stress, psi
1400
1200
1000
800
600
400
200
0
0.0000
0.1000
0.2000
0.3000
0.4000
0.5000
0.6000
0.7000
Shear Displacement, in.
East lvdt
West lvdt


Portugues Dam RCC
Panel D / B6
Mixture 6d (40% Fly Ash); 2,000 deg F-hr Joint Maturity: With Bedding Mortar
Nominal Normal Stress = 400 psi
Shear Displacement (back LVDT), in.
0.0000
0.1000
0.2000
0.3000
0.4000
0.5000
0.6000
0.7000
Shear Displacement (primary LVDT), in.
Rotation

Selected Results: BiAxial Direct Shear

Joint Treatment	Peak/Initial* Cohesion, psi
Design Mix, 500^{o}F-Hr	266
Design Mix, 2000^{o}F-Hr	275
75% Ash, 2000^{o}F-Hr	139
Design Mix, 2000^{o}F-Hr w/bedding	448
Design Mix, 2000^{o}F-Hr Retarded	408
Design Mix, 2000^{o}F-Hr Clean Sand	316

***Tests at age 90-days**

Selected Results: Direct Tensile Strength Tests

Joint Treatment	Direct Tensile* Strength, psi
Design Mix, 500°F-Hr	385
Design Mix, 2000°F-Hr	220
75% Ash, 2000°F-Hr	180
Design Mix, 2000°F-Hr w/bedding	345
Design Mix, 2000°F-Hr Retarded	275
Design Mix, 2000°F-Hr Clean Sand	285

***Tests at age 365-days**

Conclusions

- The comprehensive test program conducted for the Portugues Dam Project has provided invaluable insight on the behavior and characteristics of RCC and other concreting materials.
- The COE has significant expertise in the design, evaluation and use of RCC. This expertise is readily accessible through the RCC DX and Materials CoP.

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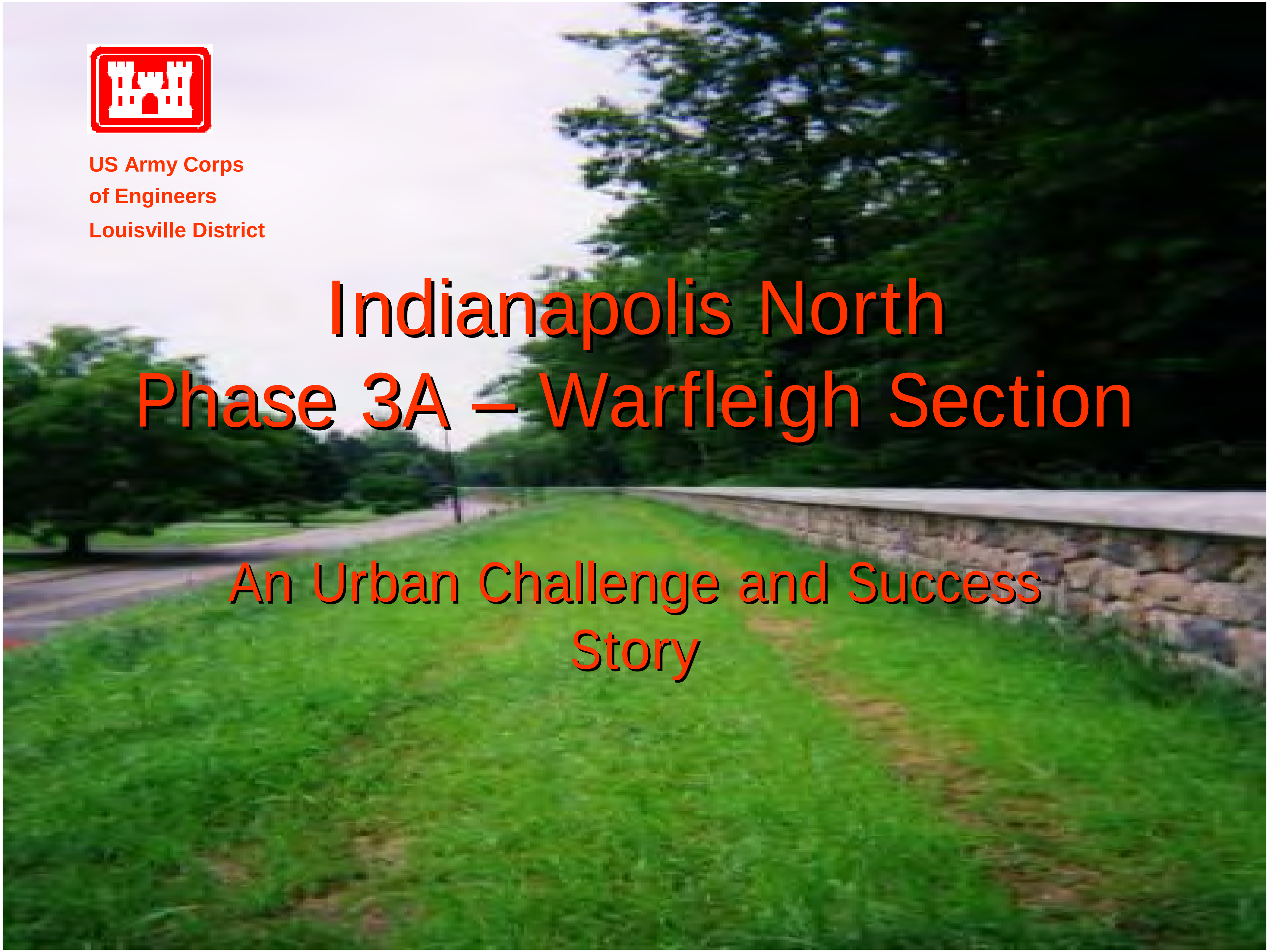
Jacksonville District

Questions?

(Thank You!)



US Army Corps
of Engineers
Louisville District

Indianapolis North
Phase 3A – Warfleigh Section

An Urban Challenge and Success Story

Project Participants

- Designer and Construction
- Sponsor
- Contractor
- Other interested Parties

Project Specifics

- Where located
- Length of Project
- Type of Project

Construction Scope of Work

Existing Conditions

CHALLENGES

- Neighborhood Concerns

TREES APPEARANCE

Nuisances

- Construction Problems

Attempting to meet the Challenges - Communication

- Listening and Informing the Neighborhood
- Partnering with the Contractor

Construction


Miller


Problems


1/21/2004


1/21/2004


1/21/2004


1/21/2004

Successful Project

- Nice Project
- Minor Budget and Time Growth

Why Successful

- Communication with neighbors
- Communication with Sponsor
- Communication within Corps Structure
- Communication with Contractor

It is Called Partnering

Fruits of Success

Evaluation and Repair Of Blast Damaged Reinforced Concrete Beams

By

MAJ John L. Hudson P.E.

US Army Corps of Engineers®

US Army Corps of Engineers®

Outline

- Purpose and Importance
- Scope
- Process
  - Beam design and construction
  - Blast loading and evaluation
  - FRP repair
  - Flexural loading
- Results
- Conclusions

Purpose and Importance

Purpose

To determine if surface mounted Fiber Reinforced Polymer (FRP) is a viable option for the repair of blast damaged reinforced concrete beams.

Importance

Terrorist attacks and combat operations in Iraq and around the world have caused significant damage to structures

Reconstruction operations in Iraq require the repair of blast damaged structures

The use of FRP may result in reduced time and costs in the repair of these structures

Scope

- 10 beams constructed using standard concrete and A 615 Grade 60 reinforcing steel

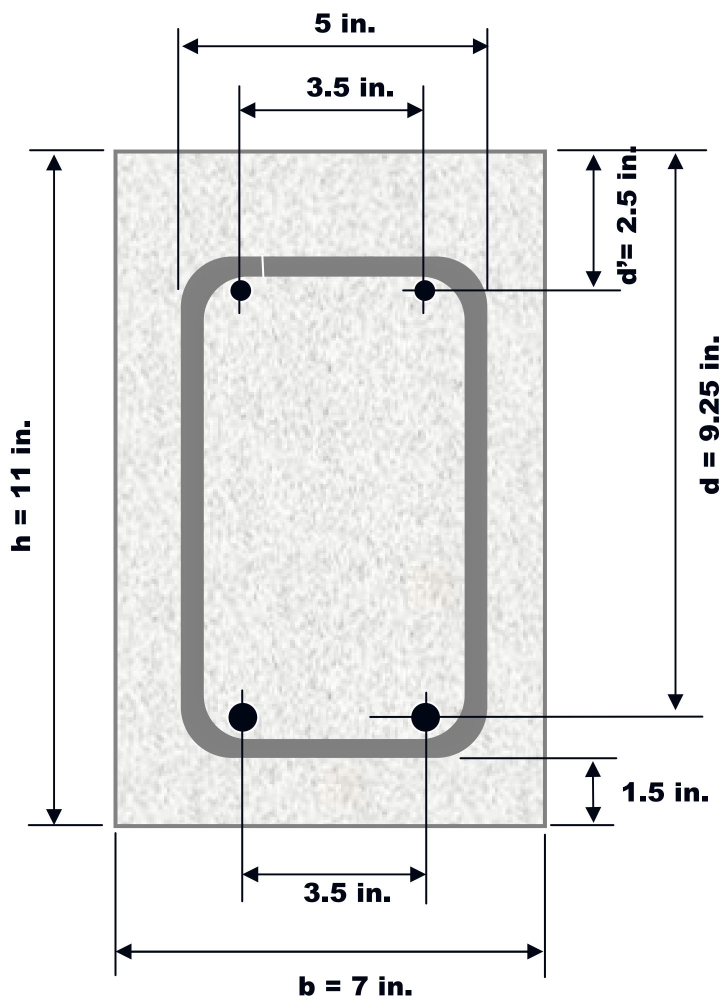
- 8 beams were blast damaged using C-4 high explosives and their damage evaluated

- 2 damaged beams were repaired using FRP

- 6 beams were tested to failure in third point loading (2 unrepaired, 2 repaired, and 2 control beams)

Process

Beam Design



- Based on ACI 318 design requirements
- Longitudinal and transverse reinforcement was the same in all beams
- Smallest, reasonably sized beam given available materials and resources
- Beam weight ~ 580 lbs.
- Beam length was 7 ft – 4 in.
- 22 stirrups at 4 in. on center

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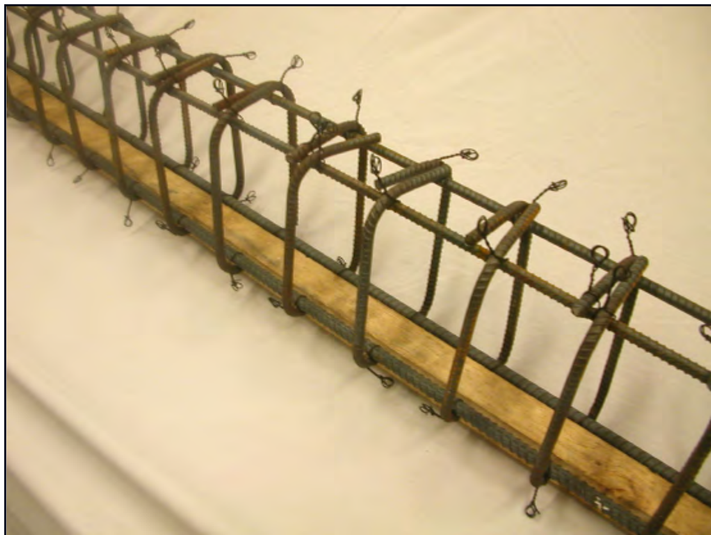
Process

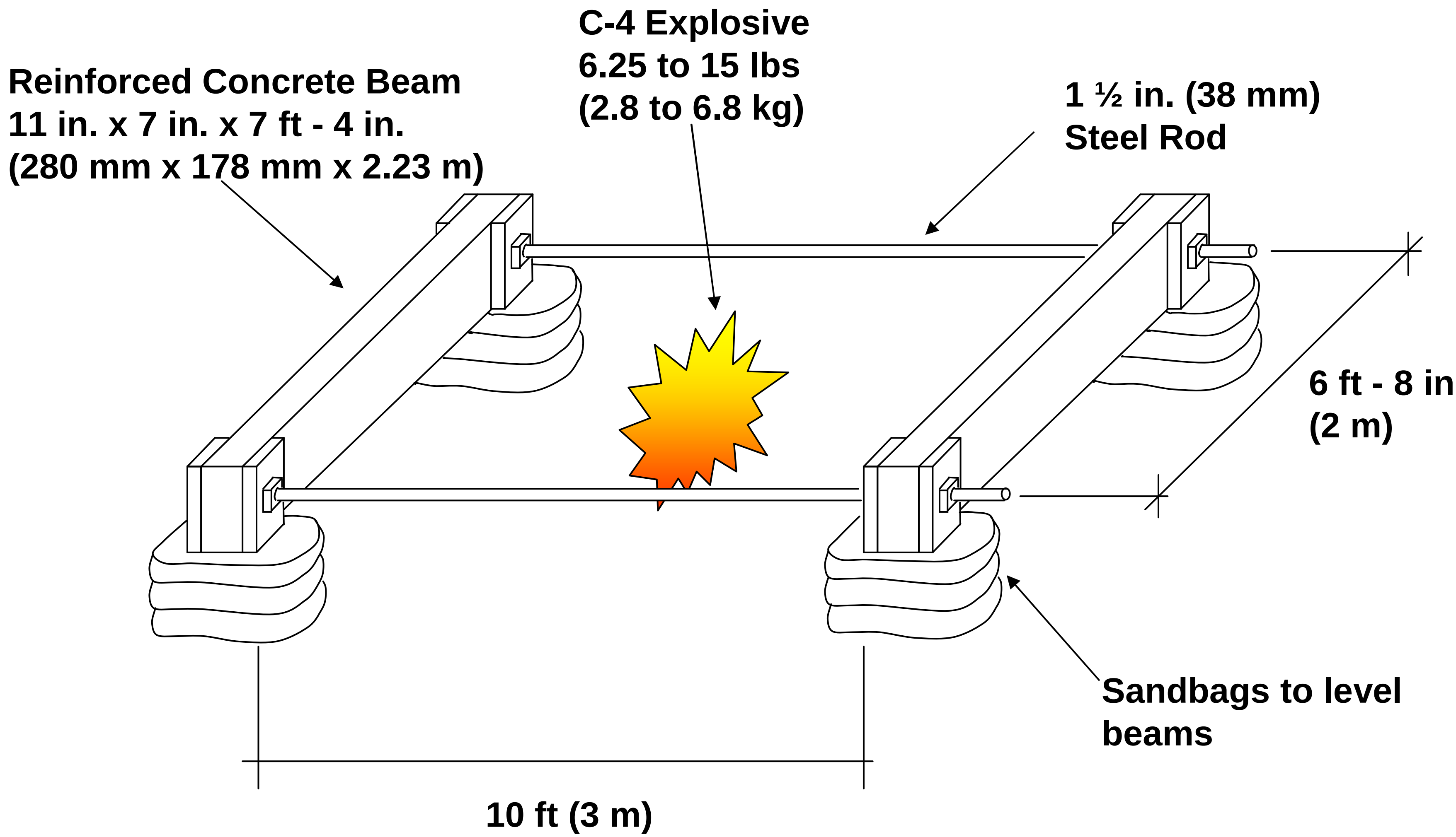
Beam Construction



- All beams were cast from the same batch of concrete.
- 4 sets of compression strength tests and one set of split cylinder tests were conducted
- Reinforcement was tested to determine yield and ultimate strength

Process

Blast Loading – Test Configurations



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Process

Blast Loading – Testing

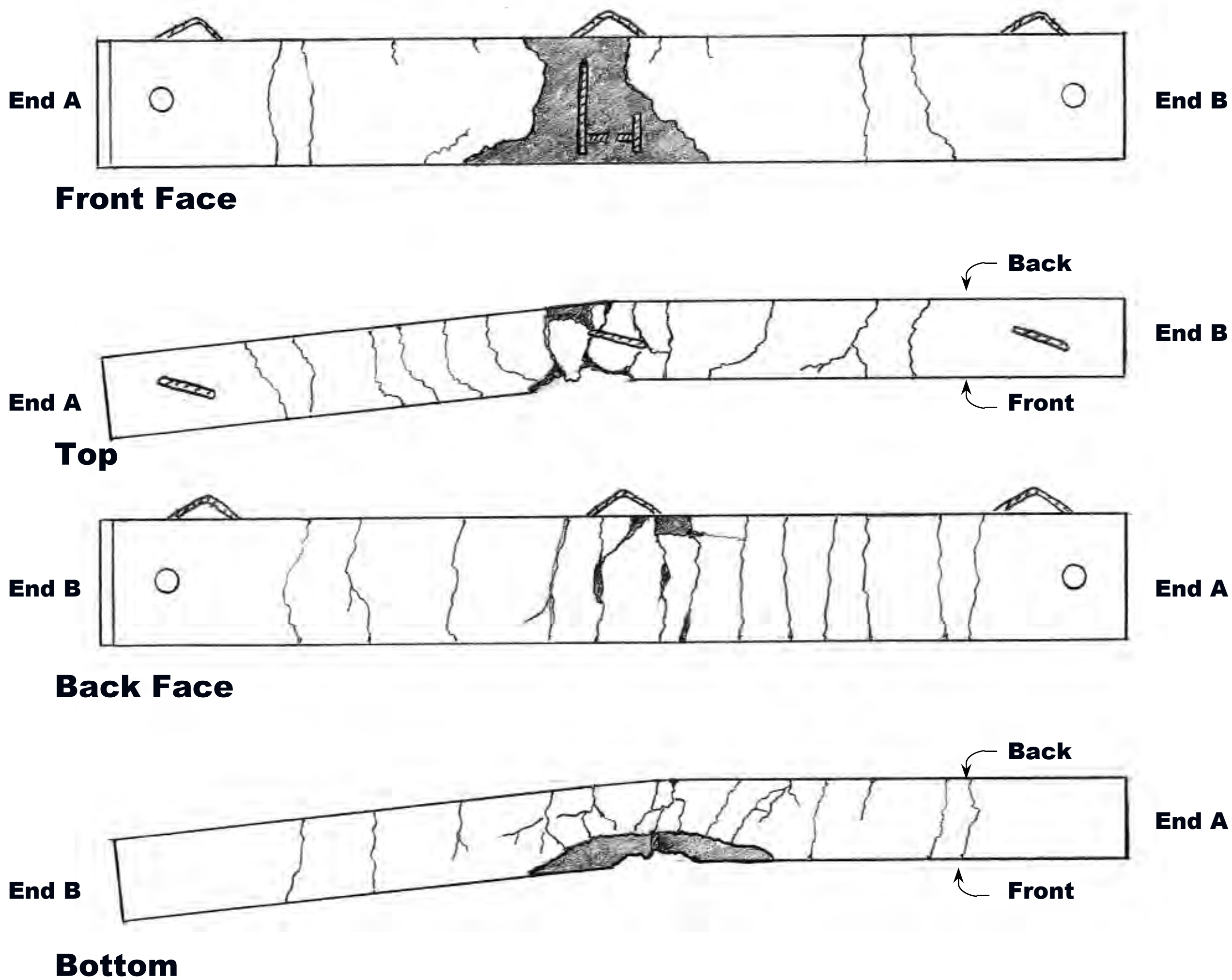
Charge tightly wrapped to minimize voids in charge

Charges placed on sand bags even with the centerline of the beams

Set 2 after detonation of charge

Process

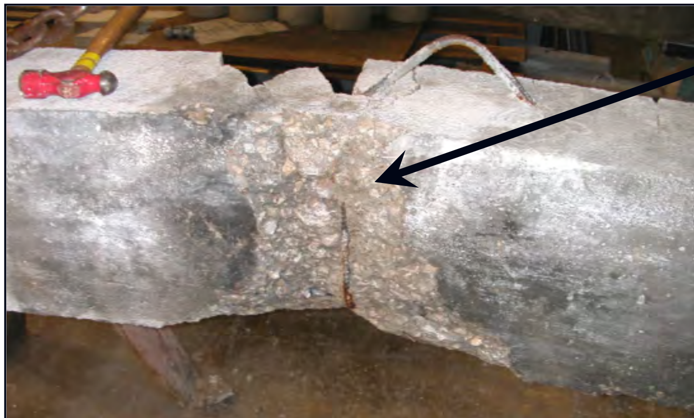
Blast Loading – Evaluation



- Each beam was sketched and all cracking, spalling and exposure of reinforcement was identified
- 2 of the 4 sets were determined to have damage beyond repair
- 3 of the 4 sets experienced permanent horizontal deformations

Process

FRP Repair – Surface Preparation



All unsound concrete was removed

Bottom edges were rounded to reduce force concentrations in FRP

Beam 2B was straightened by jacking it against an undamaged beam

Process

FRP Repair – High-strength mortar

The edges around the area in which the high-strength repair mortar was placed were cut ½ in. (13 mm) deep using a masonry blade on a skill saw.

Beam 2B after the repair mortar has cured

Compression strength test was conducted on three mortar cylinders yielding an average strength of 8900 psi

Process

FRP Repair – Application of FRP

Beams 2B and 4A were sandblasted prior to application of the FRP Primer to remove any surface contaminates

One coat of MBrace Primer was applied to each beam using a short nap roller

The primer cured for approximately 18 hours resulting in a clear, shiny, slightly tacky surface.

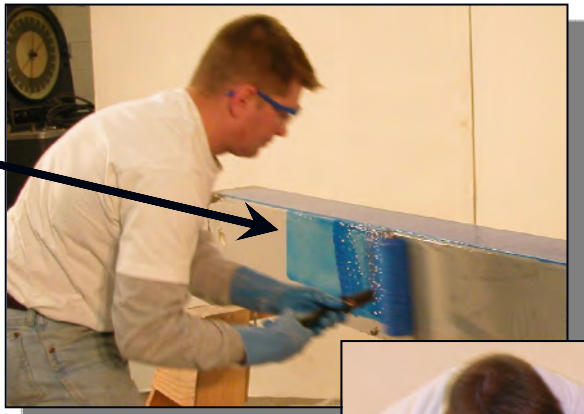
Process

FRP Repair – Application of FRP

The MBrace Putty is applied in a thin coating to smooth the surface of the beam.

The MBrace Putty cured for approximately six hours before the saturant was applied.

The MBrace Saturant was applied to each beam using a medium nap roller.



The first layer of carbon fiber fabric was applied running parallel to the beam's primary axis. This layer of fabric provided tensile reinforcement to the beams.

Process

FRP Repair – Application of FRP

A 2nd layer of saturant was applied on top of the fabric. The saturant was applied generously to ensure that the fabric was fully saturated.

The second layer of carbon fiber fabric was applied on top of the fully saturated longitudinally oriented fabric.

A final layer of saturant was applied to the beams on top of the shear reinforcement fabric.

Process

FRP Repair – Application of FRP

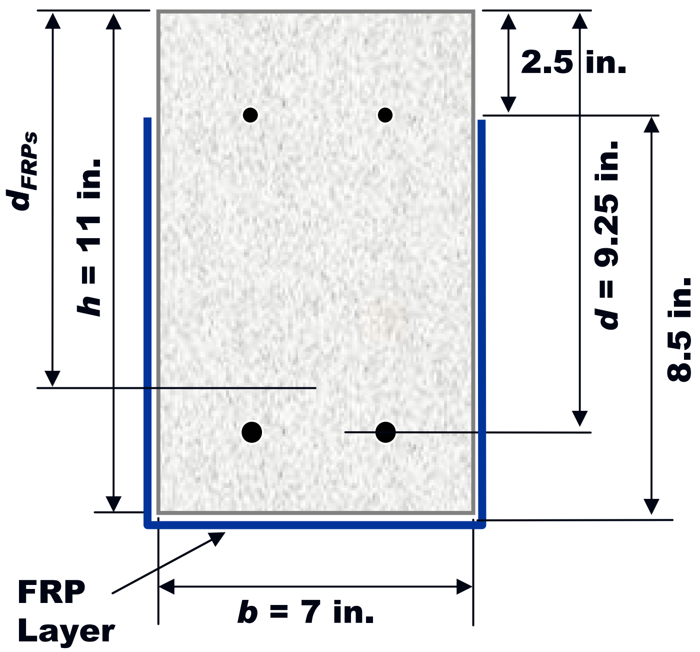
Application of the three layers of saturant and two layers of carbon fiber fabric took approximately 15 to 20 minutes per beam.

After 24 hours the beams were still tacky and by 48 hours they were tack free.

The FRP takes seven days to reach its full load carrying capacity.

Process

FRP Repair – Flexural Strength Increase



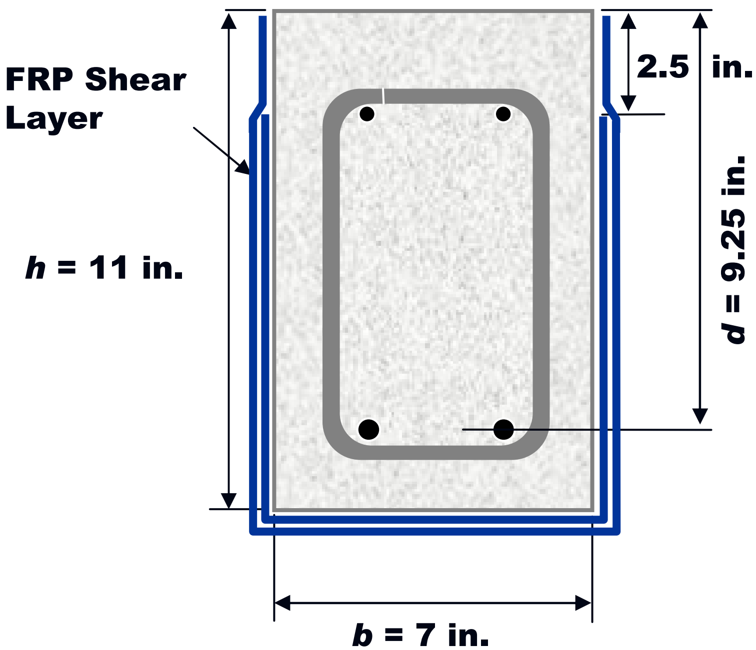
- Cross sectional area of FRP was 0.1560 in² but only 0.1495 in² was in tension
- Iterative process was used to determine increase in strength in beam due to FRP assuming beam was undamaged
- FRP results in an overreinforced section and provides a 40% increase in moment capacity for an undamaged beam

Material Properties Used in Calculation	f'_c psi	f_y psi	f_{FRPy} psi	c in	M_n ft-kips	Predicted maximum total load lbs	f_{FRPb} at failure psi
Design Properties	3500	60000	550000	3.13	39.9	39940	218700
Actual Material Properties	5160	82000	550000	3.00	50.9	50870	232300

Process

FRP Repair – Shear Strength Increase

- **The shear reinforcement was U-wrapped from the top edge on one side to the top edge on the other side**

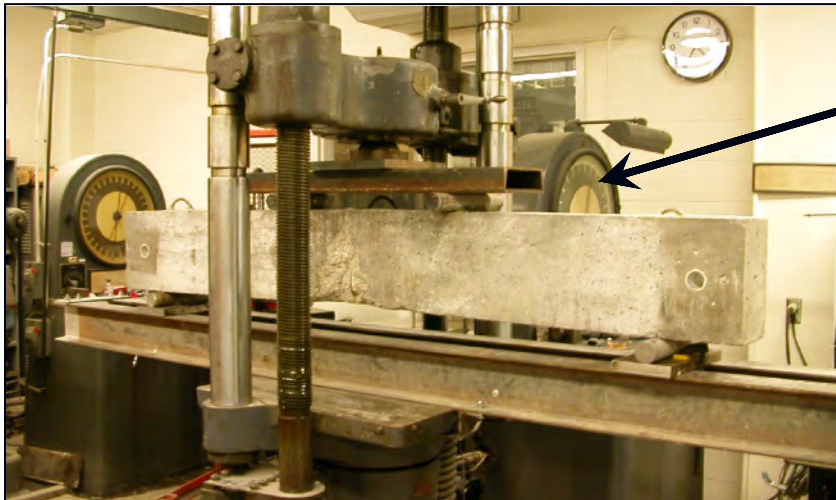


- **With a calculated shear strength of 59.0 kips (262 kN), the shear strength did not govern the strength of the beams.**

Material Properties Used in Calculation	f'_c psi	f_{fe} psi	f_y psi	A_{fv} in.^{2}	V_f kips	V_u kips
Design Properties	3500	112500	60000	0.99	16.1	53.3
Actual Material Properties	5160	123000	66000	0.99	17.6	59.0

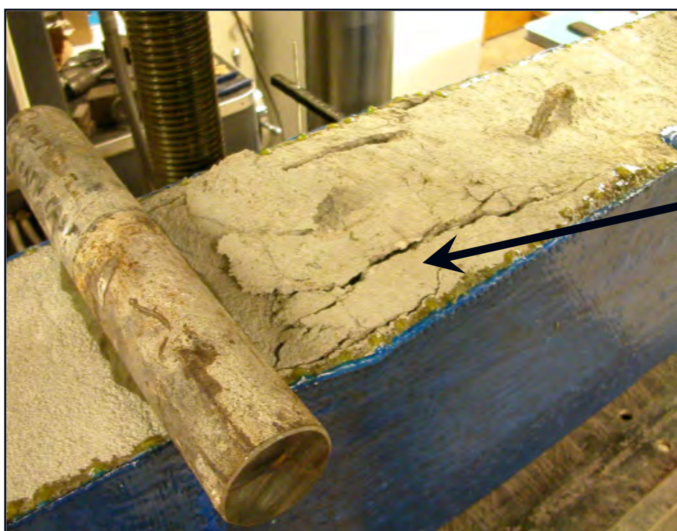
Process

Load Testing



Beams were mounted in the third-point reaction frame on the 120 kip Baldwin Universal Testing Machine.

Displacement transducer measured the deflection of the centerline of the beam.



Compression failure in the concrete of beam 4A after reaching a load of 56,700 lb

Results

Blast Damage Evaluation

- **Sets 1 (15 lbs) and 3 (10 lbs) experienced significant damage to the concrete and yielding of the steel with horizontal deflections between 2½ and 3 in.**

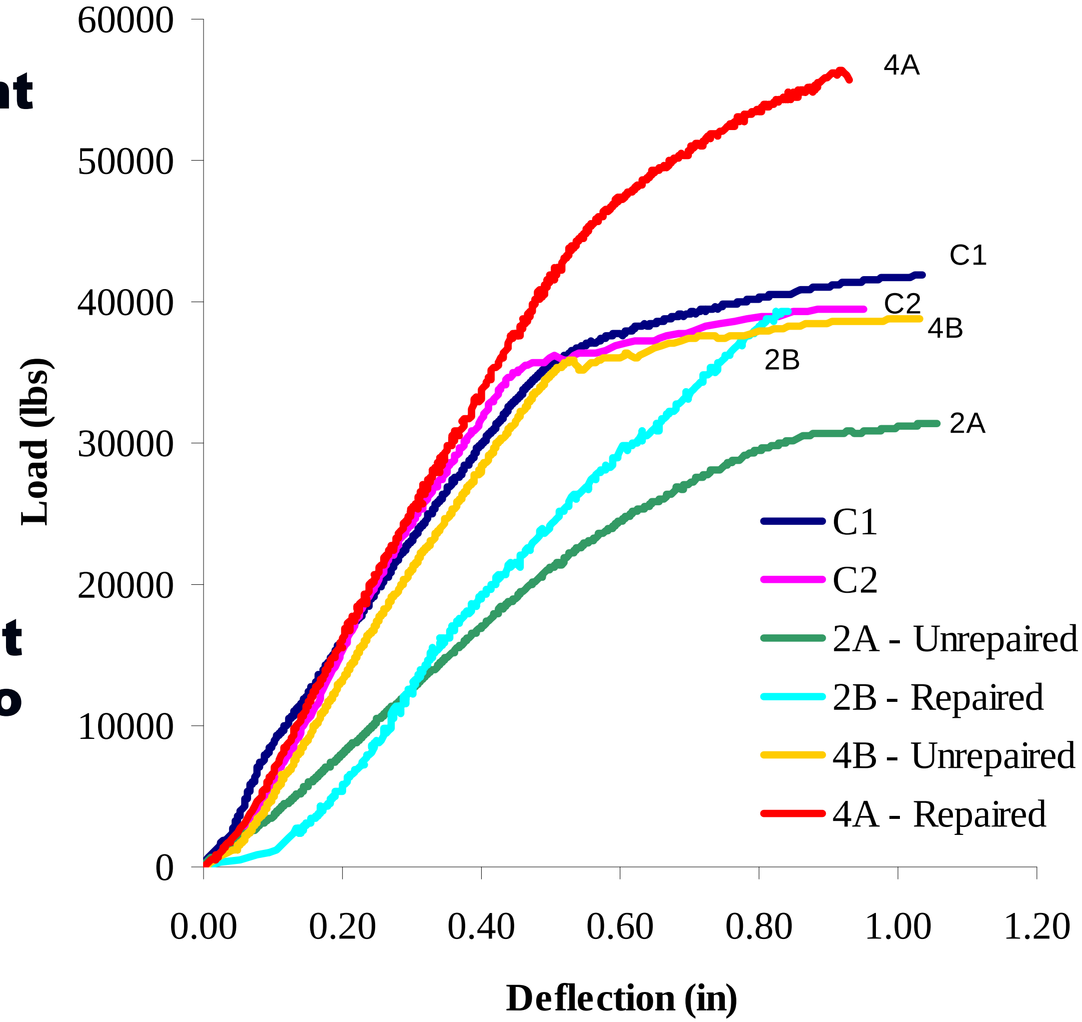
- **Set 2 (11.25) experienced less significant damage to the concrete and yielding of the steel with horizontal deflections of 1½ in. on both beams**

- **Set 4 (6.25 lbs) resulted in flexural cracking through the beams at several locations but no apparent yielding of the steel**

- **Damage inflicted on the 2 beams of each set was similar but not the same**

Results
Flexure Test

- Both repaired beams demonstrated a significant improvement in strength
- All 6 beams ultimately failed when the concrete at the top center of the beam crushed
- Beam 2B did not experience any significant nonlinear behavior prior to yielding
- Beam 4B demonstrated very similar behavior to the control beams



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Results

Flexure Test

Beam Identifier	Beam type	Predicted maximum total load lbs	Maximum total load lbs	Approx. load at initiation of nonlinear behavior lbs	Deflection at failure in	Change in capacity
C1	C	36400	41900	35000	1.04	N/A
C2	C	36400	41500	35000	0.95	
2A	D	36400	31175	N/A	1.06	126 %
2B	D+R	51220	39350	N/A	0.84	
4A	D+R	51220	56700	46000	0.93	145 %
4B	D	36400	39000	36000	1.03	

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Conclusions

- FRP is a viable option for the repair of blast damaged beams. The FRP repaired beams demonstrated a significant improvement in flexural capacity in comparison to their equivalently damaged counterparts.

- Blast damaged beams can be repaired even after experiencing flexural and shear cracking, crushing of concrete, and yielding of reinforcement.

- FRP is a relatively simple and easy repair system to install.

- The addition of FRP to beams can result in an overreinforced section, thereby preventing any significant yielding prior to a brittle fracture of the concrete.

Cost

- FRP estimated cost of material and labor

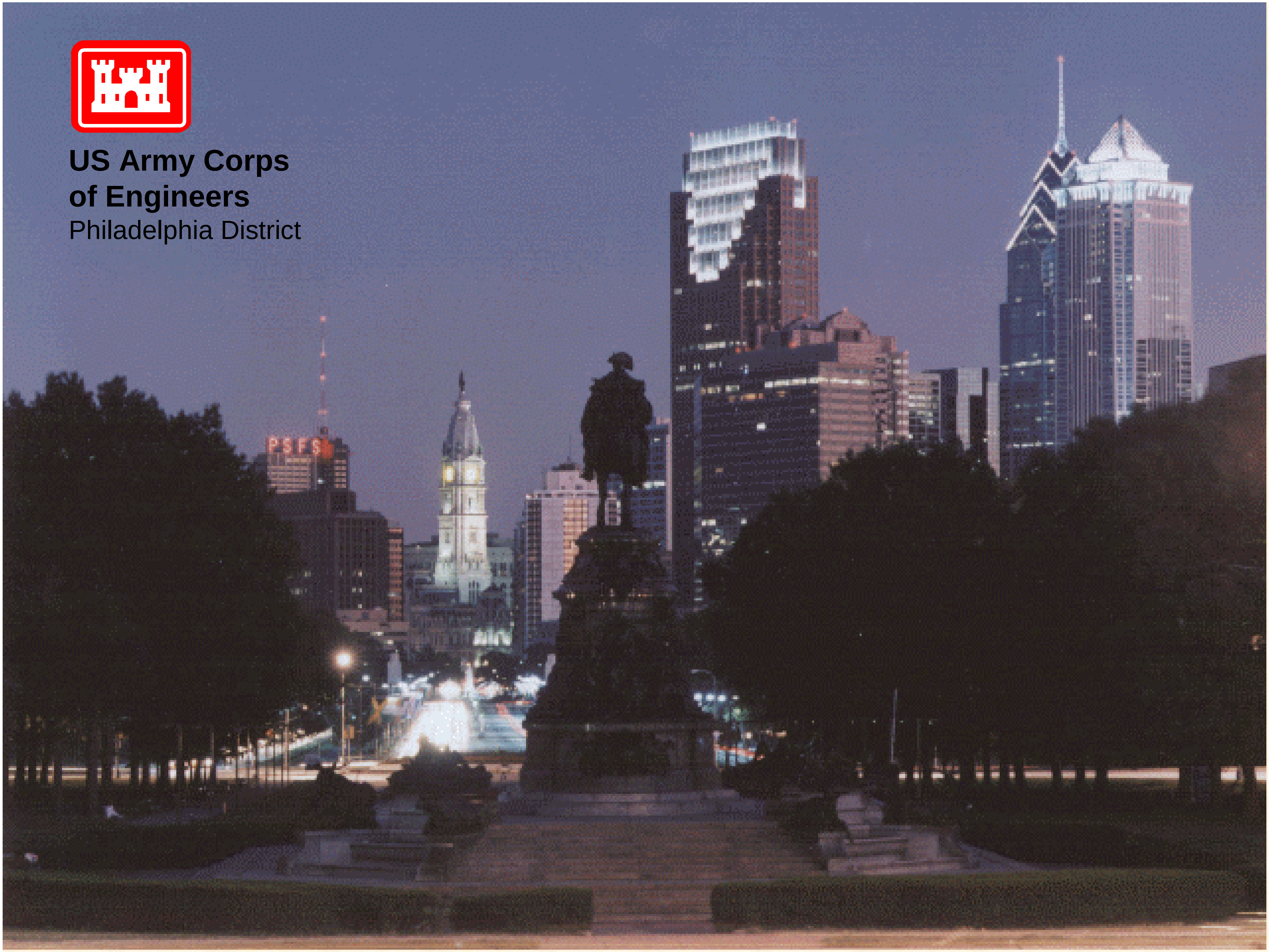
Surface prep and 1st layer of FRP	-	$20 per sqft
Each additional layer	-	$15 per sqft

- Material costs are approximately $6-7 per sqft
- The greatest variables in FRP project costs relate to access cost, i.e. removal and replacement of walls/ceilings and scaffolding
- The repaired beams used in this project would have cost approximately $1000 each to repair

US Army Corps
of Engineers®

Questions

- MAJ John Hudson, PE
- USACE – Omaha District
- 710.333.2976 – phone
- John.l.hudson@nwo02.usace.army.mil


US Army Corps
of Engineers
Philadelphia District
PSFS

Building an In-house Bridge Inspection Program

This presentation will address the development of Philadelphia District's in-house bridge inspection capabilities and take an in-depth look at several successful bridge inspection efforts.

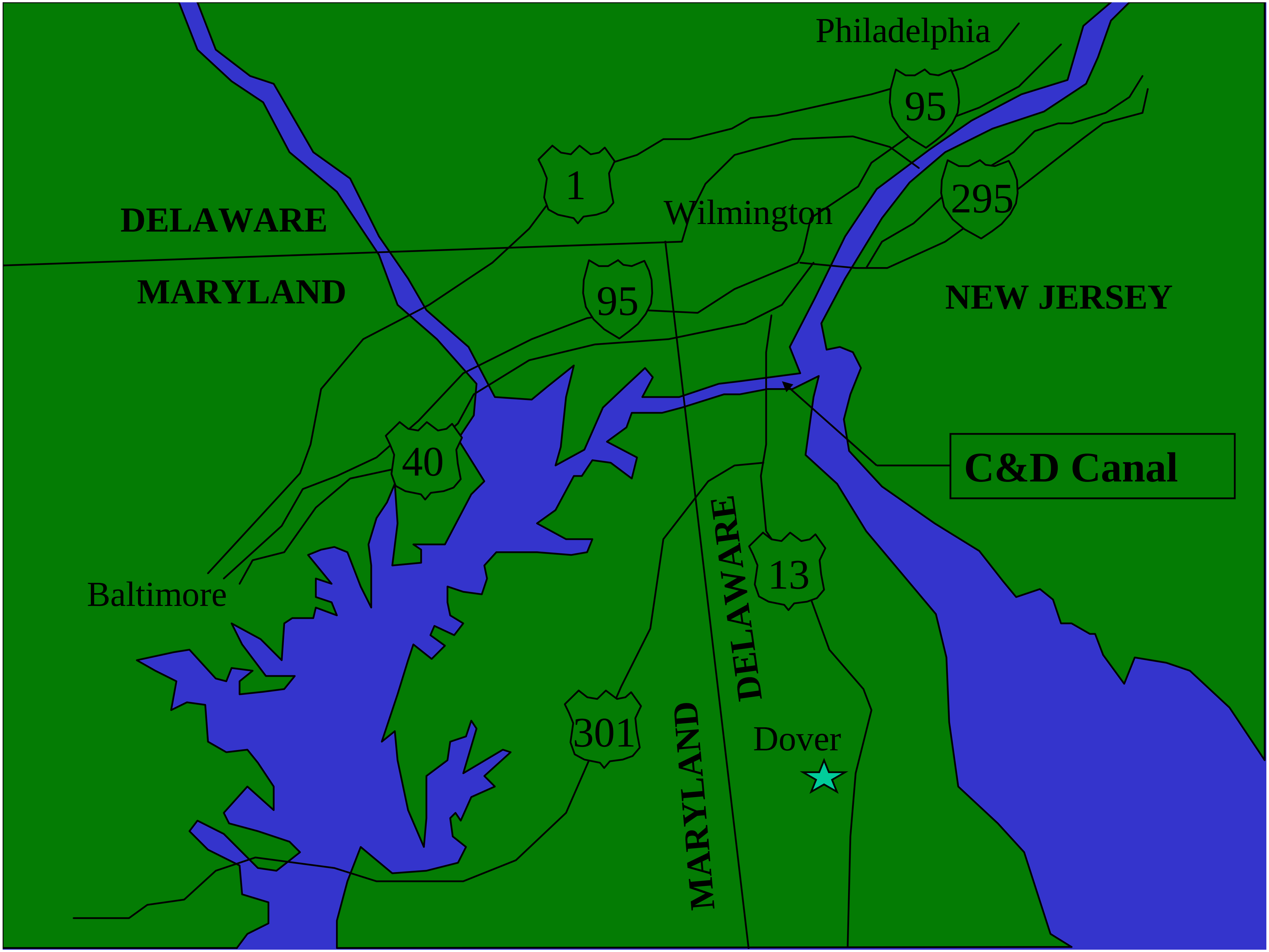
INTRODUCTION

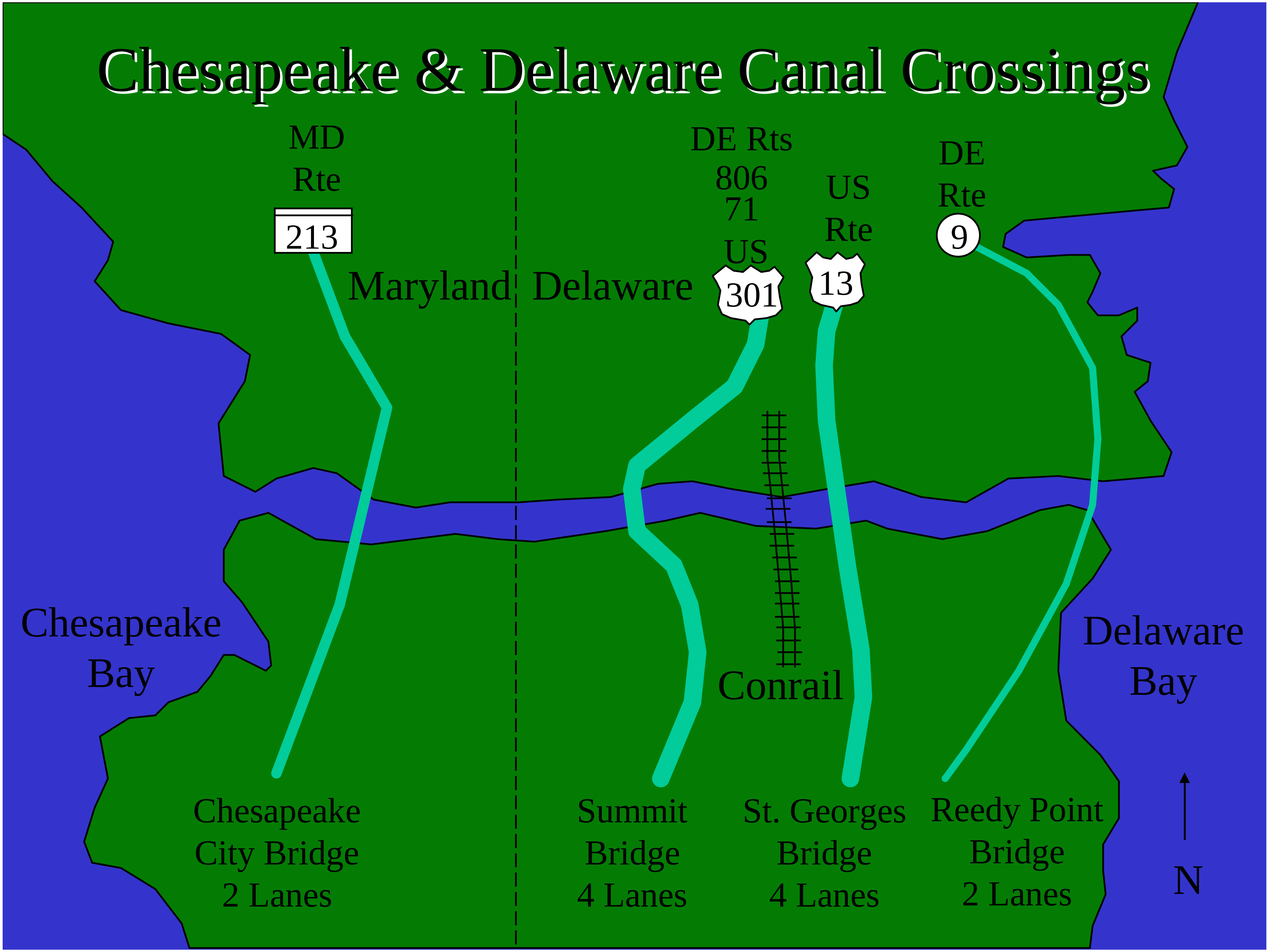
- Four high-level highway bridges, Chesapeake and Delaware Canal, DE & MD

INTRODUCTION

Philadelphia Engineer District

- Four non-public service and spillway bridges at the Northeastern PA dams


Philadelphia
95
1
295
DELAWARE
Wilmington
MARYLAND
95
NEW JERSEY
40
C&D Canal
13
Baltimore
DELAWARE
301
Dover
MARYLAND


Chesapeake & Delaware Canal Crossings
MD Rte
213
Maryland
Delaware
DE Rts 806 71
US 301
US Rte
13
DE Rte
9
Conrail
Chesapeake Bay
Delaware Bay
Chesapeake City Bridge 2 Lanes
Summit Bridge 4 Lanes
St. Georges Bridge 4 Lanes
Reedy Point Bridge 2 Lanes
N

PHILADELPHIA DISTRICT BRIDGE PROGRAM

INSPECTIONS

BRIDGE INSPECTION PROGRAM

Philadelphia Engineer District

- STARTING SMALL:
- In 1995 the team's first inspection – Delaware City Bridge
  - every two years ever since (1997, 1999, 2001, 2003, 2005)
- Started inspecting the Dam bridges in the year of their Periodic Inspection:
  - F.E. Walter Dam Service Bridge in 1997 and 2002
  - Beltzville Dam Service and Spillway Bridges in 1998 and 2003
  - Blue Marsh Dam Service Bridge in 1999, 2004

BRIDGE INSPECTION PROGRAM

Philadelphia Engineer District

- GETTING LARGER:
- Until 2003, the District utilized A/E firms to inspect their high-level highway bridges
- 2003 – St. Georges Bridge
  - first of the BIG bridges – 4,209ft structure, tied-arch, 42 spans!
  - financial reasons
  - team of 7 inspectors
  - competitive timeframe and cost with A/E
- 2004 - Reedy Point Bridge
- 2005 - St. Georges Bridge again
- 2006 - SUMMIT BRIDGE
- 2007 - CHESAPEAKE CITY BRIDGE

St. Georges Bridge

2003

Reedy Point Bridge

2004

St. Georges Bridge 2005

INSPECTION FOR OTHERS

- In late 1999, Fort Dix contacted NAP about inspection on 8 bridges on base in 2000.
- In 2001, NAP inspected 6 bridges at Tioga-Hammond Lakes in PA for Baltimore District and 5 bridges in Iowa and Nebraska for Kansas City District.
- In 2002 and 2004, NAP inspected the Fort Dix bridges again.
- In 2003, NAP returned to Tioga-Hammond Lakes.
- In 2005, NAP inspected 18 bridges for Baltimore District, incl. Tioga-Hammond, Almond, Cowanesque, Stillwater and Whitney Point Lakes.

Fort Dix, NJ


Tioga-Hammond Lakes, Mansfield, PA



Cowanesque Lake, PA


Stillwater Lake, PA


Whitney Point Lake, NY

INSPECTION TEAMS

- Usually teams are two people, two engineers or an engineer and a technician.
- District Inspection team (distributed thru EC and Ops):
  - Five engineers, three have P.E.'s
  - Four technicians
  - Two more engineers get trained this year
- Team leader(s) must be a P.E. (we need more P.E.s)
- Bridge manager plans the inspection, coordinating the notes, acquiring equipment and allocating the work.
- Team leader usually writes the report(s).
- Bridge manager also coordinating any A/E inspections at the same time.

IN HOUSE SUPPORT

Philadelphia Engineer District

- NAP owns own snooper, crash truck, MPT equipment, safety boat
- Equipment operators in OPS trained as inspectors
- NAP Survey Branch:
  - Provides multibeam scour surveys
  - Provides data in color contour drawings

KEYS TO SUCCESS

Philadelphia Engineer District

- **Preparation**
  - Preparation of notes – create a library for each bridge
  - Take the time to put note sheets in CAD
  - Create a system for notes and documentation
  - Our inspectors find graphical method best
  - BRIDGE FILE component of new CEBIS program will be invaluable
  - Create list of equipment suppliers
  - Ask for input from bridge firms
  - talk to other districts (i.e. NAP) about preparing cost estimates, timeframe (how long an inspection should take)
  - create a good attack plan for the inspection (critical path and secondary work)

KEYS TO SUCCESS

Philadelphia Engineer District

- **In the field:**
  - ***Pair team members with good, complementary skill sets***
  - ***Support work (i.e. rigging, testing, diving)***
  - ***BE FLEXIBLE – things never go like they're supposed to go***

Prioritization Issues

Philadelphia Engineer District

- Coordinating Inspection Schedule with Funding Schedule
  – Recommendation and Action Summary – identify future work items
  – Scheduling of future work vs. scheduling future funding
  – Ensure that contracts contain most current information - Good information from inspectors is paramount.

Prioritization Issues

Philadelphia Engineer District

- Coordinating Inspection Schedule with Funding Schedule
- Deciding What Work Can Wait and What Work Cannot
  - Inspectors/Bridge Program Manager/Ops Project Manager coordination

Contact Information

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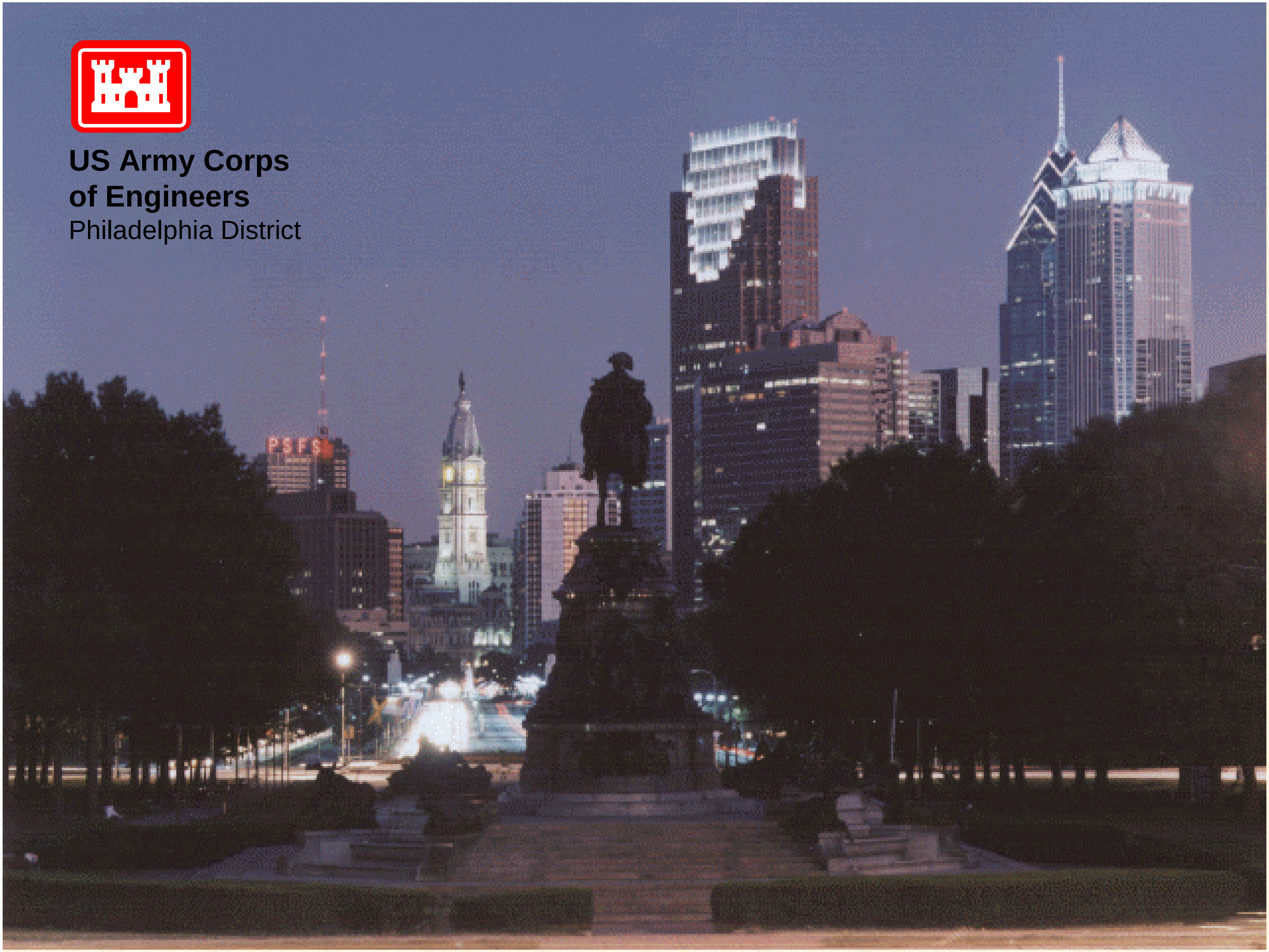
Bridge Program Manager/Design Branch
U.S. Army Corps of Engineers
Philadelphia District
215-656-6652
Jennifer.c.laning@usace.army.mil

US Army Corps
of Engineers
Philadelphia District



PORTUGUES DAM

PROJECT UPDATE

US Army Corps of Engineers ®
Jacksonville District

PORTUGUES DAM

- **Alberto Gonzalez, P.E. – Project Manager**
- **Jim Mangold, P.E. – Project Engineer**
- **Dave Dollar, P.E. – Structural Designer**
- **Geotechnical, Geology, Materials, Hydraulic, Civil, Mechanical, Electrical, ITR Team**

US Army Corps of Engineers ®
Jacksonville District

PORTUGUES DAM

- Jim Hinds - CENWP – RCC Mix Design
- Tony Bombich and Billy Neeley – CEERD – Materials Testing
- Ahmed Nisar, Paul Jacob – MMI Engineering – Thermal Stress/Strain Analysis (NISA)

PORTUGUES DAM

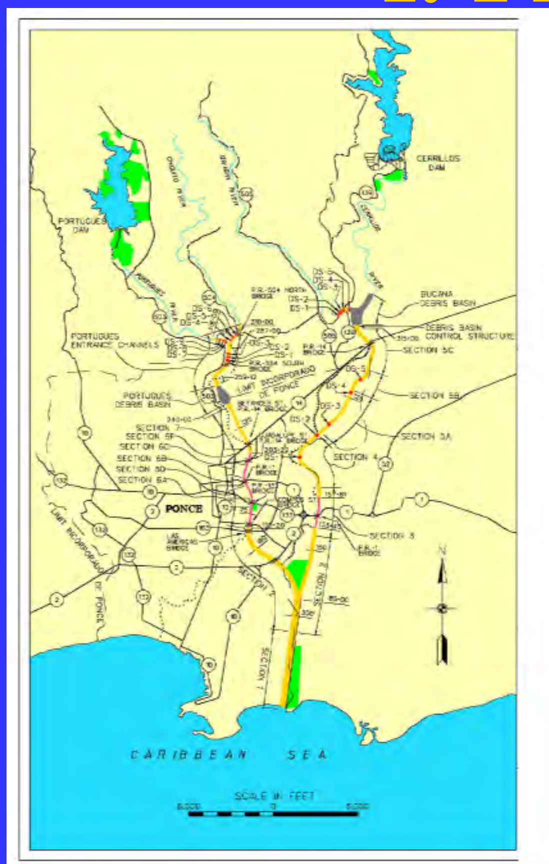
I. Project Overview
II. ITR Process
III. Current Schedule
IV. MCE Update
V. Dam Design

PORTUGUES DAM
I. Project Overview

PORTUGUES DAM
I. Project Overview

PORTUGUES & BUCANA RIVERS PROJECT

I. Project Overview



- CHANNEL IMPROVEMENTS
  - CONCRETE U-CHANNEL
  - GABION LINED
  - UNLINED
- DROP STRUCTURES
- CONTROL STRUCTURES
- DEBRIS BASINS
- CERRILLOS DAM
- PORTUGUES DAM

PORTUGUES DAM

I. Project Overview

PORTUGUES DAM
I. Project Overview

PORTUGUES DAM

I. Project Overview

Concrete Thin Arch Dam was advertised in September 2000 and the bid was outside the awardable range

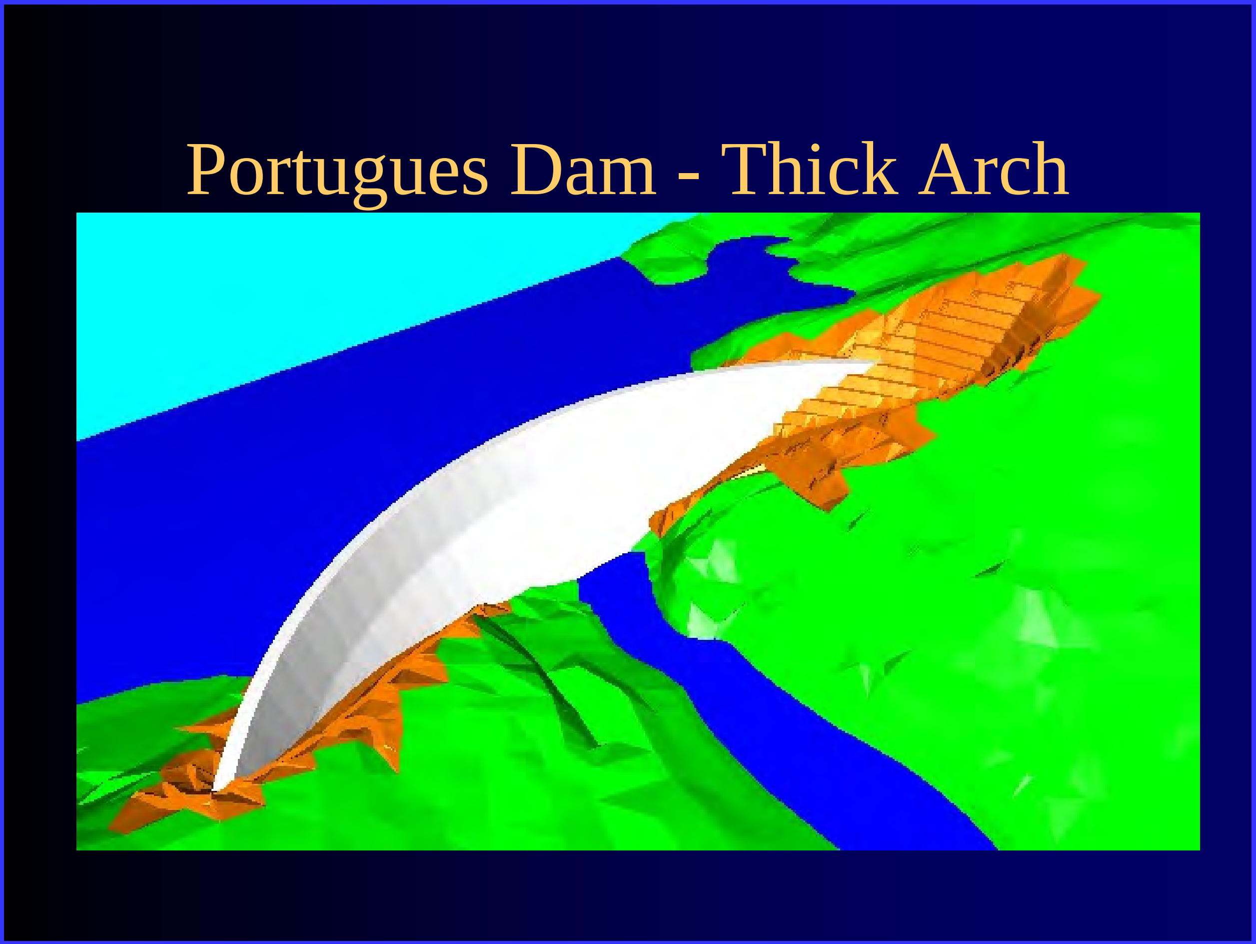
Design changed to RCC

PORTUGUES DAM
I. Project Overview

Pertinent Data:

- **HEIGHT: 219.6 FT**
- **CREST LENGTH: 1300 FT**
- **SPILLWAY CREST WIDTH: 150 FT***
- **FLOOD CONTROL STORAGE: 9484 AF**
- **MAX POOL AREA: 215 ACRES**

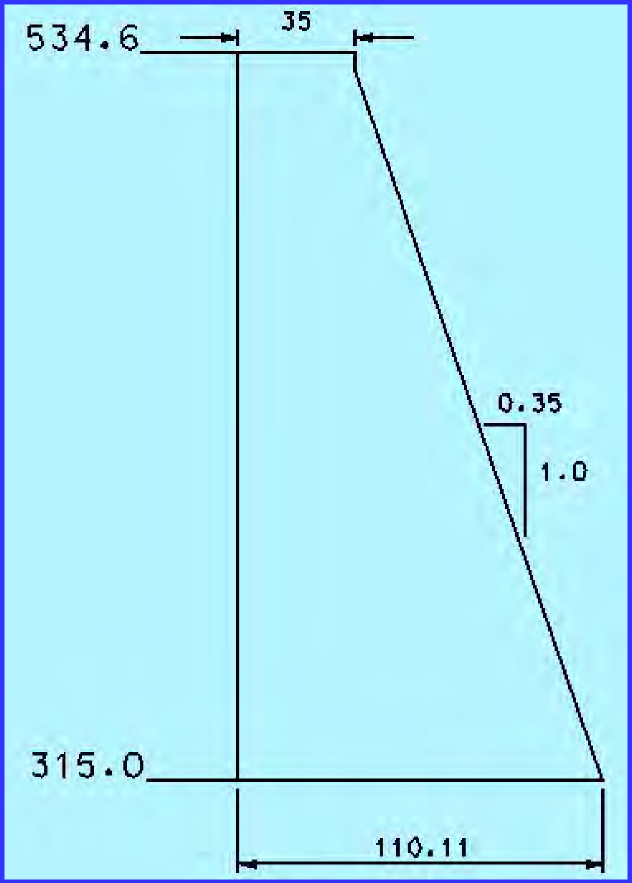
PORTUGUES DAM
I. Project Overview



PORTUGUES DAM
I. Project Overview

PORTUGUES DAM
I. Project Overview

PORTUGUES DAM
I. Project Overview



- **TYPE OF SECTION**
- **CUT CONTRACTION JOINTS**
- **GROUT CONTRACTION JOINTS?**
- **GERCC FACING**
- **TEST PLACEMENT**
- **MIX DESIGN**
  - **18 sec VEBE**
  - **340 lbs cementitious mat'ls, 40% class F fly ash**
- **VOLUME ~ 375,000 CU. YDS.**

PORTUGUES DAM
II. ITR Process

- THIN ARCH
- RCC
  - FORMALIZED PROCESS
  - CONSISTENT WITH INDUSTRY PRACTICE

PORTUGUES DAM
II. ITR PROCESS

- Multidiscipline ITR team.
  - Concrete dam design, RCC mix design, seismology of the Caribbean, engineering geology, geotechnical engineering, hydraulics, electrical and mechanical engineering.

PORTUGUES DAM
II. ITR PROCESS

Multidiscipline ITR team:	Individuals:
Concrete dam design	Glenn Tarbox
RCC mix design	Gary Mass
Seismology of the Caribbean	Dr. William McCann
Engineering geology	Alan O’Neil
Geotechnical engineering	Dr. Gregg Korbin, Dr. Don Banks
Hydraulics	MWH staff
Electrical engineering	MWH staff
Mechanical engineering	MWH staff

PORTUGUES DAM
III. Current Schedule*

- COMPLETE P&S – MAY 2006
- ADVERTISE – MAY 2006
- AWARD – AUG 2006

*THIS SCHEDULE IS DEPENDENT ON AVAILABILITY OF PROJECT FUNDING

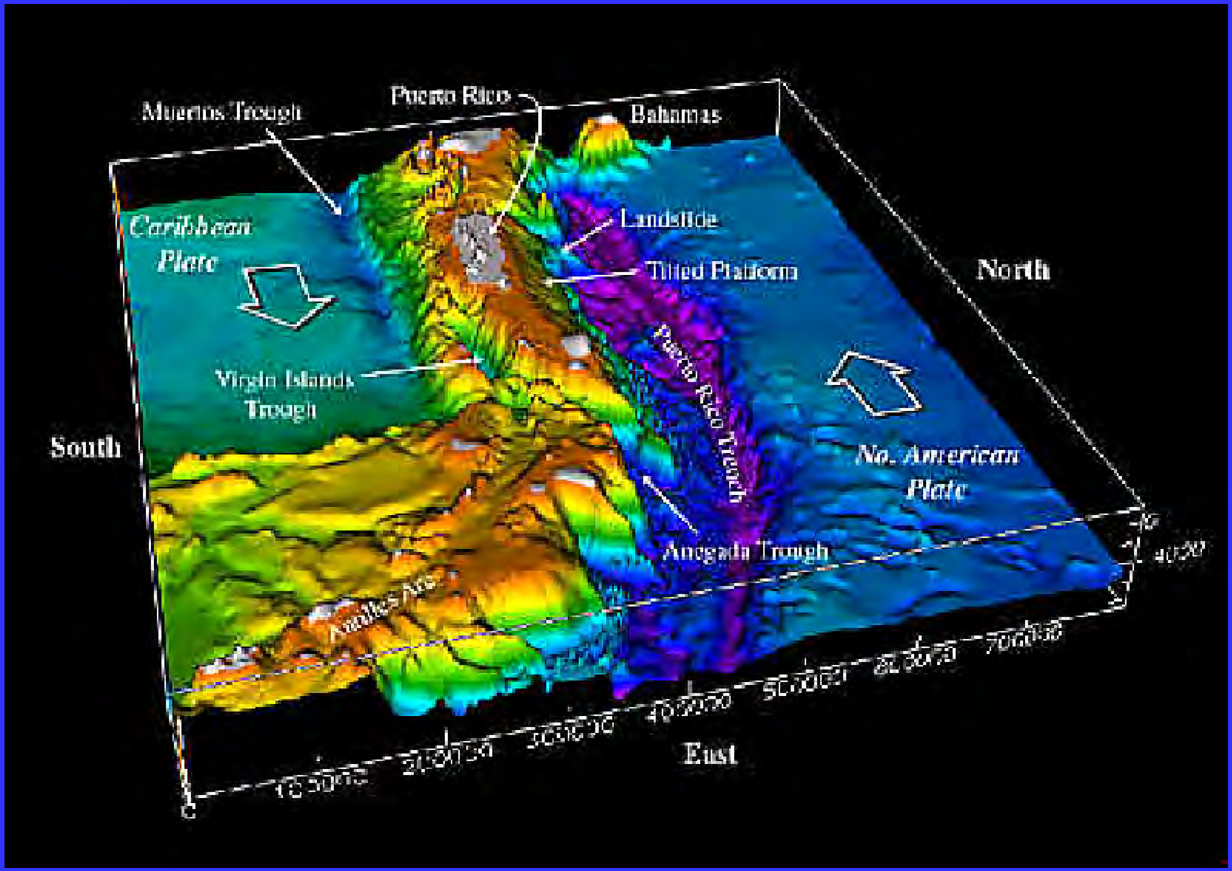
PORTUGUES DAM
IV. MCE Update

MCE – Controlling Events:

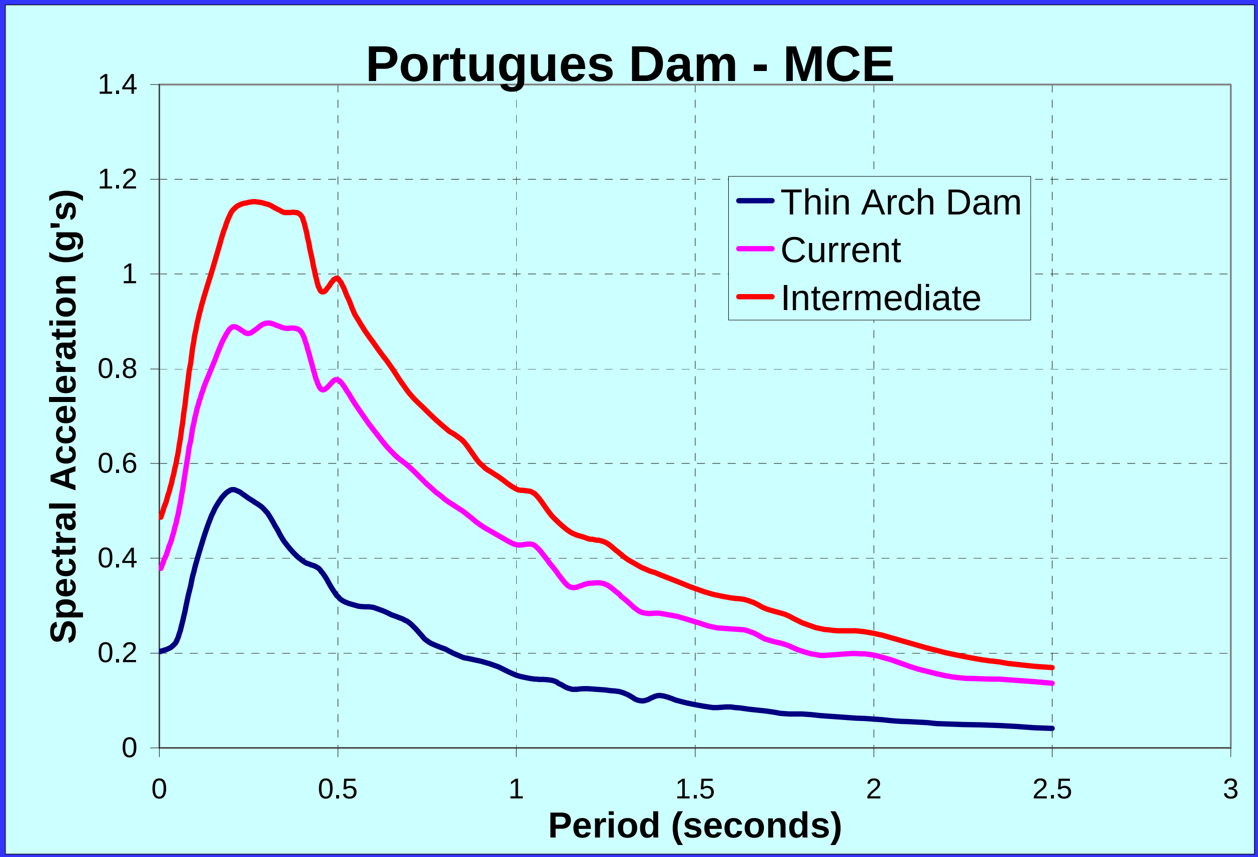
- **Thin Arch Dam**
  - **M6.5 @ 18km – Salinas Fault – 1988**
- **RCC Thick Arch Dam**
  - **M8.25 @19.6km – Muertos Trough – 2004**

"Deterministic and Probabilistic Seismic Hazard Analysis for Portugues Dam, Puerto Rico," 6 April 2004, prepared by URS Corporation; reviewed by ITR Team (particularly Dr. William McCann), Dr. Greg Fenves, ERDC (Dr. Donald Yule), USGS (Dr. Charles Mueller)

REGEONAL GEOLOGY



PORTUGUES DAM
IV. MCE Update



PORTUGUES DAM
IV. MCE Update

Significance to dam design:

- **Peak ground acceleration: 0.38g's.**
- **Plateau on the response spectrum throughout the range concrete dam frequencies of vibration.**

PORTUGUES DAM

V. Dam Design

Sequencing of Design Activities:

Construction for the thin arch dam had begun(excavation & grout curtain); therefore, there was a need to minimize the time required to redesign the dam. Activities that would normally run sequentially were performed in parallel.

PORTUGUES DAM

V. Dam Design

Parallel Activities:

- **Site Seismicity**
- **Determination of Foundation Properties**
- **Foundation and Slope Stability**
- **Concrete Mix Design and Property Testing**
- **Dam Design**
- **Thermal Analysis**

PORTUGUES DAM

V. Dam Design

DISADVANTAGES OF PARALLEL ACTIVITIES

ACTIVITY	INPUT REQUIREMENTS
1. Dam Design	1. Foundation Properties, Seismic Input, Concrete Properties.
2. Foundation Stability	2. Dam Shape and Loads, Seismic Input
3. Thermal Analysis	3. Dam Shape, Construction Sequencing, Concrete Properties
4. Mix Design	4. Target Parameters

PORTUGUES DAM

V. Dam Design

Design Approach:

Based on expected magnitude of seismic loading; design a workable mix with reasonable bond strength (tensile strength) and design the dam to maximize cantilever compression on the upstream face under usual loadings and arch compression during the seismic loading.

PORTUGUES DAM

V. Dam Design

Design Progression:

- Corps experience with RCC has typically been associated with gravity dams.
- The district considered an RCC gravity structure in the 1980's but ruled it out, not based on cost, but on the "newness" of the technology.

PORTUGUES DAM

V. Dam Design

Design Progression:

- **Gravity dam alignments and sections were evaluated.**
- **Detailed cost estimates, which included the quantities of RCC and excavation for the gravity dam designs, indicated a cost savings compared to the thin arch dam.**

PORTUGUES DAM

V. Dam Design

<u>Design Progression</u>:

- **Now that a more economical construction method was adopted could further savings be realized by minimizing the volume by designing a thick arch structure?**
- **Preliminary layouts indicated that a thick arch dam could be designed with less than 3/4 the volume of the gravity dam.**

PORTUGUES DAM

V. Dam Design

Design Progression:

- **To maintain simplicity during construction a section was adopted with a vertical u/s face and a d/s face with a single slope.**
- **Sensitivity analyses were performed to evaluate:**
  - **Relative stiffness of the arches and cantilevers**
  - **Effect of varying the horizontal curvature**
  - **Effect of stiffening the upper arches**
  - **Magnitude of temperature and reservoir load compared to gravity load**

PORTUGUES DAM

V. Dam Design

Design Progression:

- **Based on the water supply dam, a full reservoir and the foundation properties from the thin arch analysis; the horizontal curvature and alignment were set prior to having the final seismic loading. The left abutment was shifted upstream to avoid highly weathered rock exposed during the thin arch excavation.**

PORTUGUES DAM

V. Dam Design

Design Progression:

- **The section was refined to increase u/s cantilever compression; mainly from gravity load, which was applied to cantilevers only.**
- **The final layout was selected and a dynamic analysis performed.**
- **The dynamic response was acceptable.**

PORTUGUES DAM

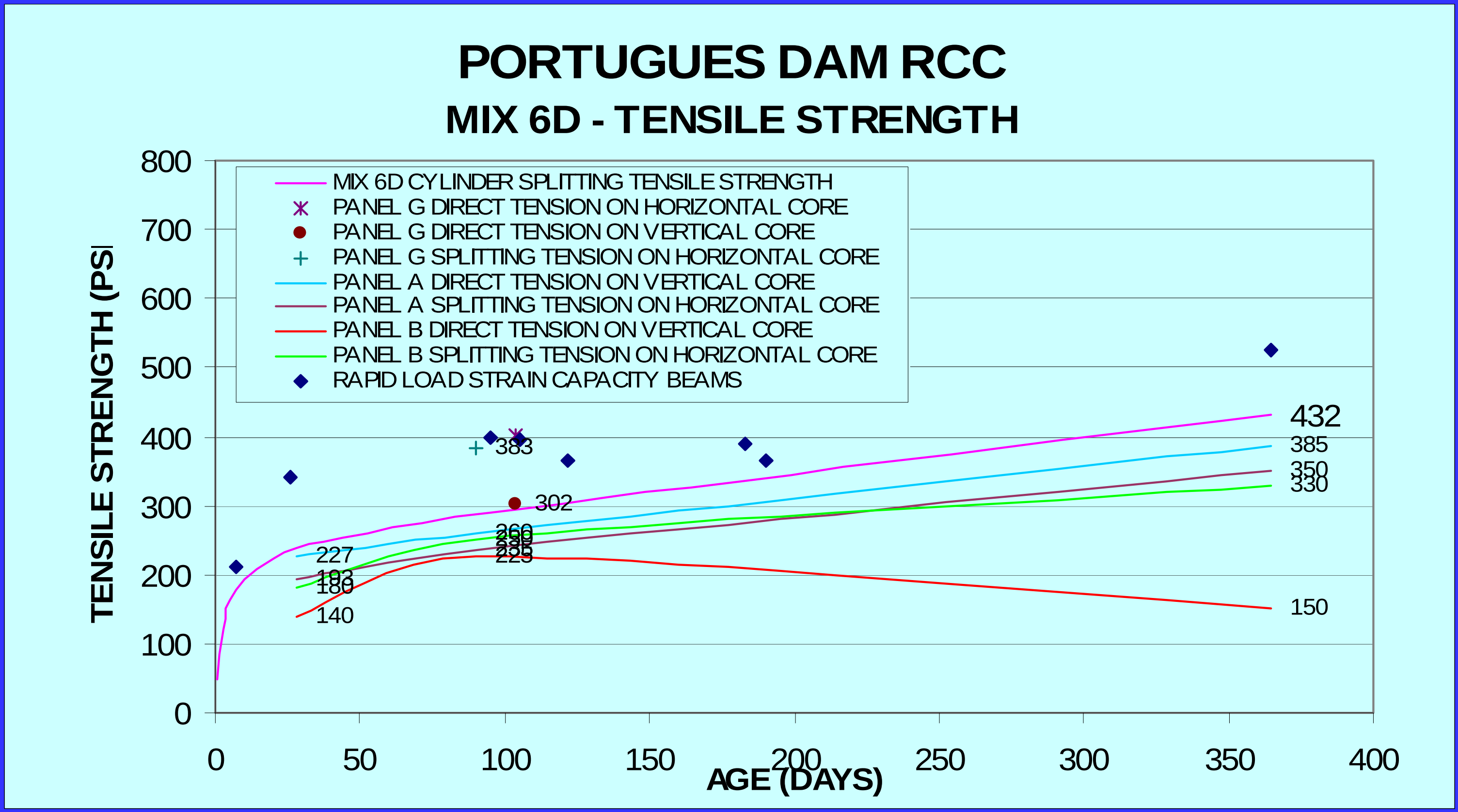
V. Dam Design

Design Progression:

- **The foundation properties were determined for the final layout. (In progress)**
- **All load cases analyzed for the final properties and loadings. (In progress)**

PORTUGUES DAM

V. Dam Design

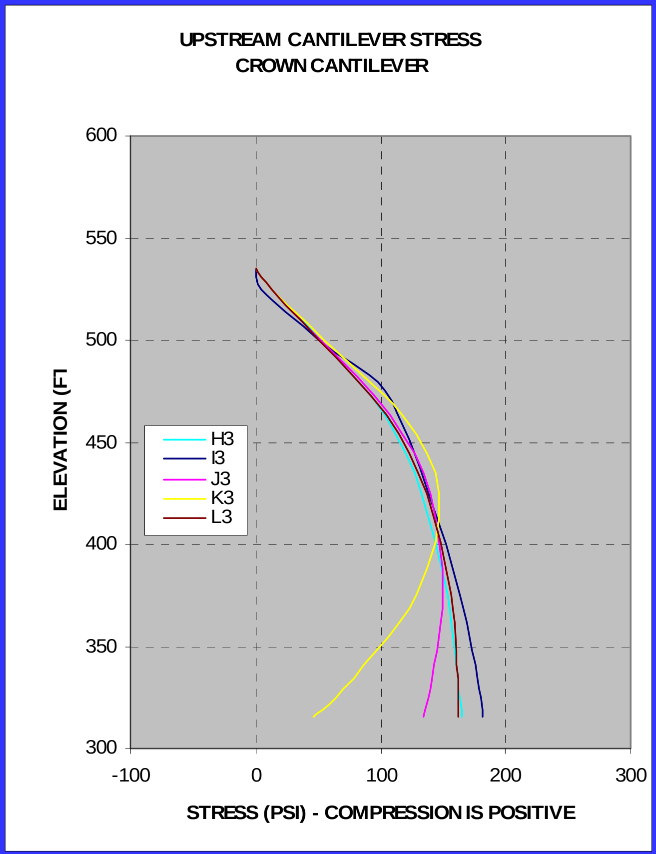


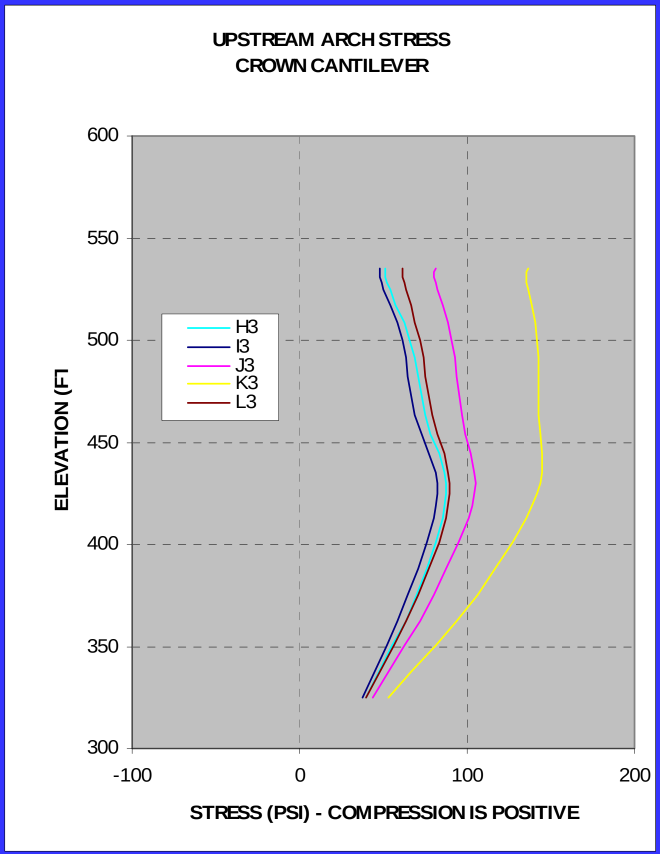
PORTUGUES DAM

V. Dam Design

LAYOUT:	VOLUMES:
G - Raxis = 825 ft, S=0.50, Crest Thickness = 25 ft	257710 CU.YDS.
H - Raxis = 825 ft, S=0.40, Crest Thickness = 30 ft	356284 CU.YDS.
I - Raxis = 825 ft, S=0.40, Crest Thickness = 35 ft	379937 CU. YDS.
J - Raxis = 825 ft, S=0.30, Crest Thickness = 35 ft	343610 CU.YDS.
K - Raxis = 825 ft, S=0.20, Crest Thickness = 35 ft	301013 CU.YDS.
L - Raxis = 825 ft, S=0.35, Crest Thickness = 35 ft	367141 CU. YDS.

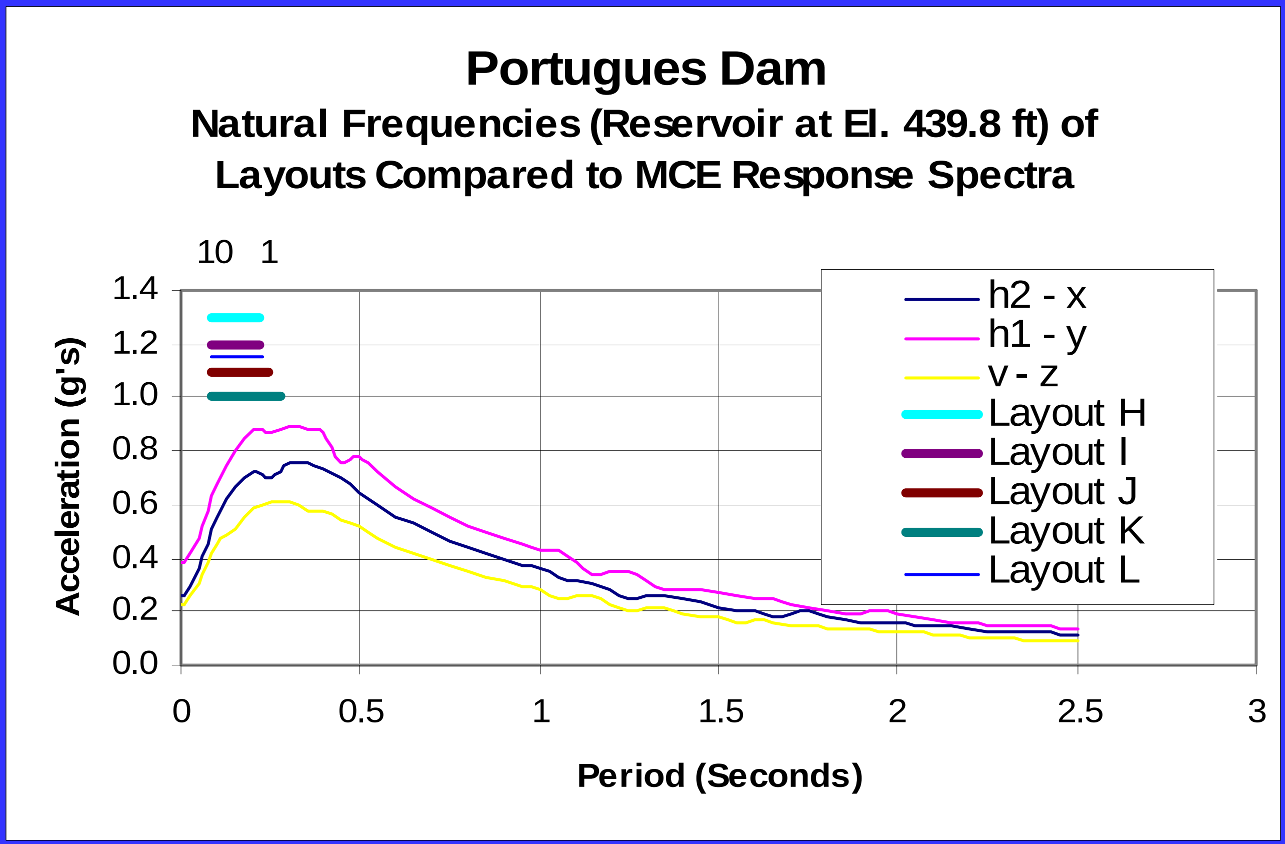
PORTUGUES DAM
V. Dam Design





WATER TO EL. 523 FT, LOW TEMPS, AND GRAVITY

PORTUGUES DAM
V. Dam Design



PORTUGUES DAM

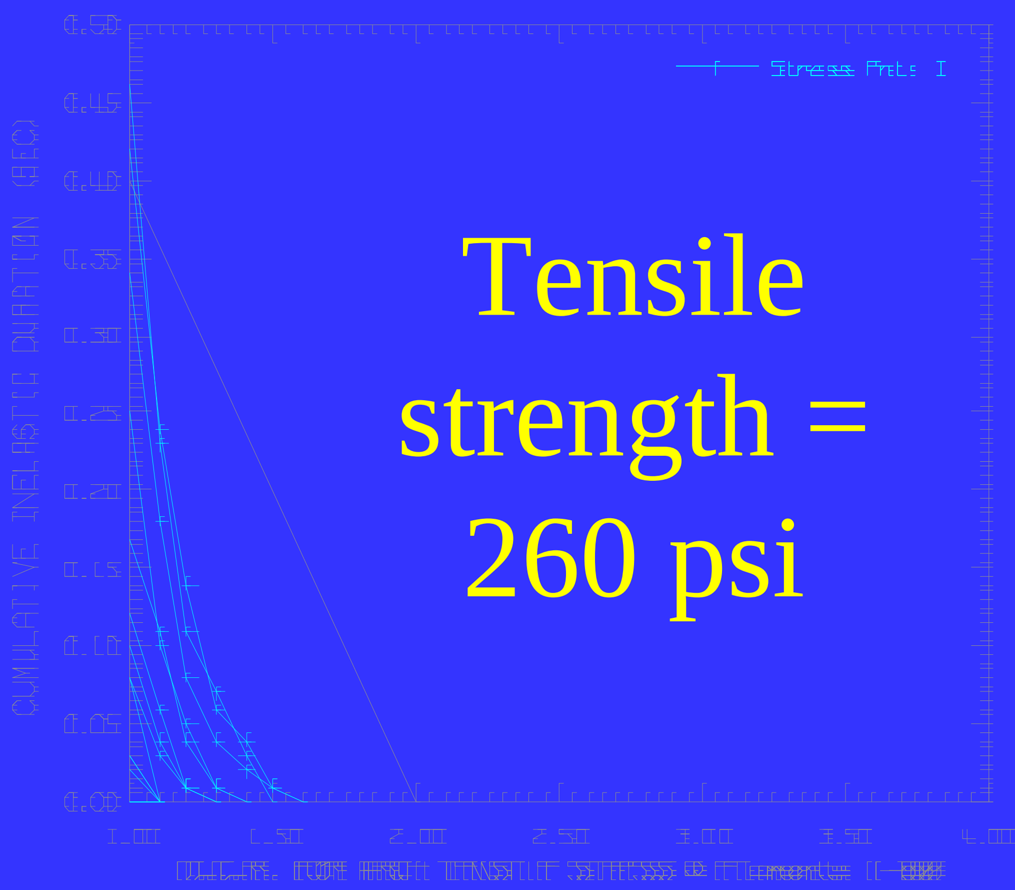
V. Dam Design

- **MAXIMUM TENSILE STRESSES**

- #1- 61,Dir: u/s,Str:arch , Max: 399.474 @ 14.010Sec
- #1- 53,Dir: u/s,Str:cantl, Max: 476.163 @ 20.240Sec
- #1-296,Dir: d/s,Str:arch , Max: 249.882 @ 14.010Sec
- #1-271,Dir: d/s,Str:cantl, Max: 384.474 @ 20.370Sec

PORTUGUES DAM

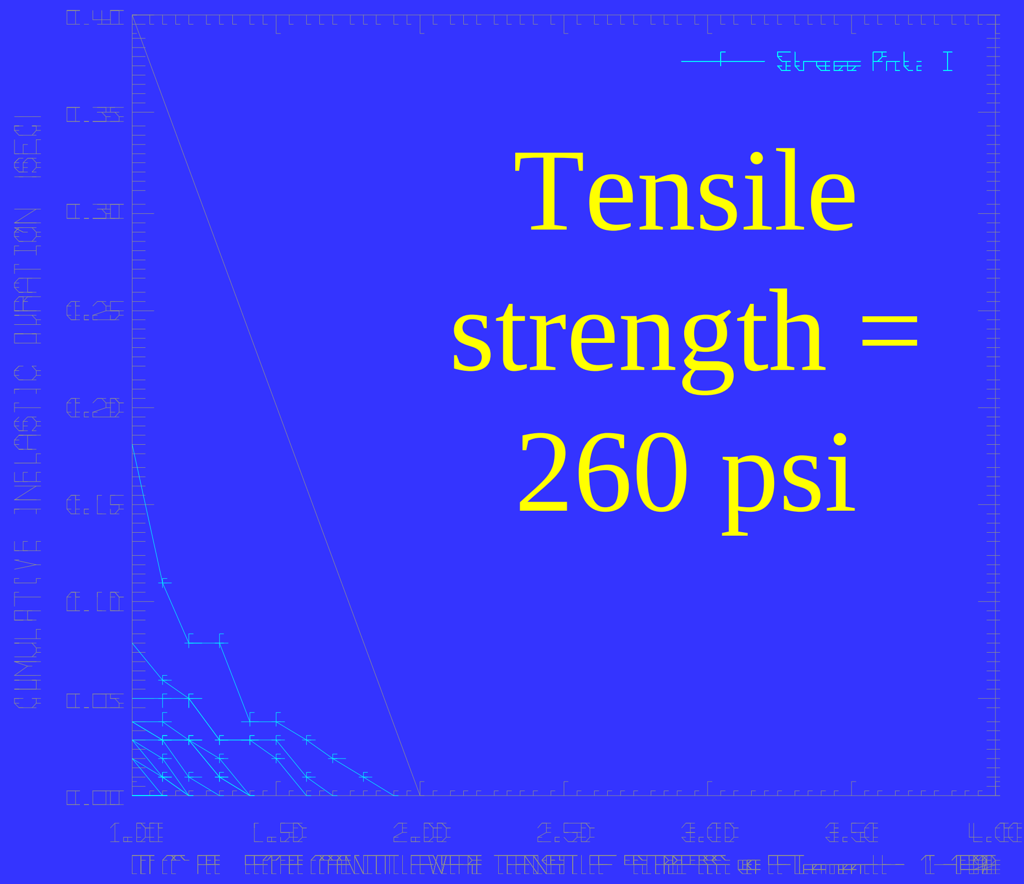
V. Dam Design–Demand/Capacity Curves



Tensile strength = 260 psi

PORTUGUES DAM

V. Dam Design–Demand/Capacity Curves



PORTUGUES DAM

V. Dam Design

Factors affecting dam design:

- **Earthquake loading**
- **Much of the dam design work and mix design preceded the determination of the earthquake loading**
- **Tensile strength of RCC structures**
- **Post thin arch excavation site conditions**
- **Use of existing thin arch grout curtain**

PORTUGUES DAM

V. Dam Design

Factors affecting dam design (continued):

- **Horizontal curvature compatible with either a flood control or water supply dam**
- **Need axis before MCE was determined**
- **Left abutment weathered rock**
- **Delays and costs associated with exploration upstream of the thin arch left abutment**
- **Mix design program preceded determination of MCE.**

THANK YOU

- RCC CONSTRUCTION PHOTOGRAPHS

RCC Placement – Upper Stillwater

RCC Placement - Olivenhain

RCC Placement - Olivenhain

RCC Placement - Saluda

RCC Placement - Saluda

Cutting Contraction Jt. - Olivenhain

Cutting Contraction Jt. - Olivenhain

Cutting Contraction Jt. - Saluda

GERCC - Olivenhain

GERCC - Olivenhain

GERCC - Olivenhain

GERCC - Olivenhain

GERCC - Olivenhain

GERCC - Olivenhain

Batch Plant - Saluda

Aggregate Cooling - Saluda

Quarry - Saluda

Pre-cast Facing Panels - Saluda

Pre-cast Facing Panels - Saluda

Contraction Joint Details - Saluda

Contraction Joint Details - Saluda

THANK YOU

- Dave Dollar, P.E. – Structural Designer
- Jim Mangold, P.E. – Project Engineer
- Alberto Gonzalez, P.E. – Project Manager

(904) 232-2459

US Army Corps of Engineers ®
Jacksonville District

US Army Corps
of Engineers
Kansas City District

Infrastructure Conference 2005

United Facilities Criteria Masonry Design for Buildings

Tom Wright, P.E.

Structural Section

Kansas City District

CENWK-EC-DS

(816) 983-3245

thomas.d.wirght@usace.army.mil

What Has Changed?

- Infrastructure Conference 2001
  - Strength Design for masonry introduced
- Infrastructure Conference 2003
  - New look at min / max reinforcement
  - Slight change in crack control (no moisture controlled units)
- Infrastructure Conference 2005
  - IBC (for the most part)
  - Crack control
  - QA / QC

Old Criteria

- TM 5-809-3 **Masonry Structural Design for Buildings**
  - Published in 1992
  - Allowable Stress (Working Stress) Design
  - Generally based on ACI 530 (MSJC)
- TI 809-04 **Seismic Design for Buildings**
  - Published in 1998
  - Uses Strength Design / performance based design
  - Applies to Life Safety Performance Objective (1A)
  - Applies to Enhanced Performance Objectives (2A, 2B, & 3B)
  - Seismic design is a good reason to use strength design

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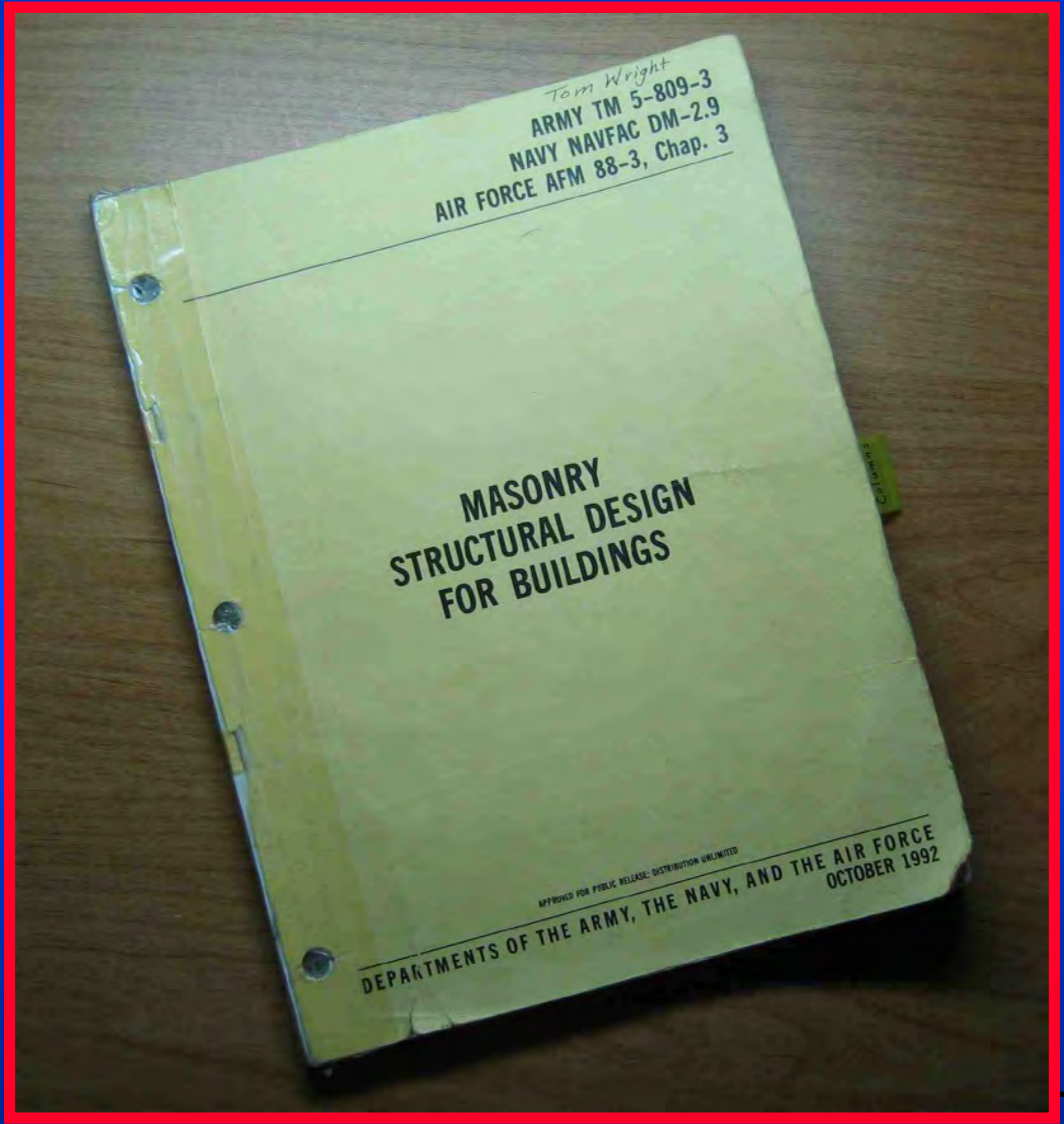
History of Masonry Criteria

- TM 5-809-3



TM 5-809-3
Chapters

1. Introduction
2. Quality Assurance In Masonry
3. Materials, Properties, Standards Tests
4. Design for Crack Control
5. General Criteria for Reinforced Masonry
6. Reinforced Masonry Walls
7. Reinforced Masonry Shear Walls
8. Lintels
9. Columns and Pilasters
10. Nondestructive Evaluation Techniques
11. Appendices A, B, and C (Design Aids for Walls and Lintels)

History of Masonry Criteria
Draft TI 809-06

1. Introduction
2. Quality Control and Quality Assurance
3. Materials
4. Design for Crack Control
5. General Criteria for Reinforced Masonry
6. Reinforced Masonry Walls
7. Reinforced Shear Walls
8. Lintels
9. Columns and Pilasters
10. Evaluation of Existing Structures
11. Appendices A, B, C, and D (Design Aids for Walls, Lintels, Columns and Pilasters)

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Kansas City District

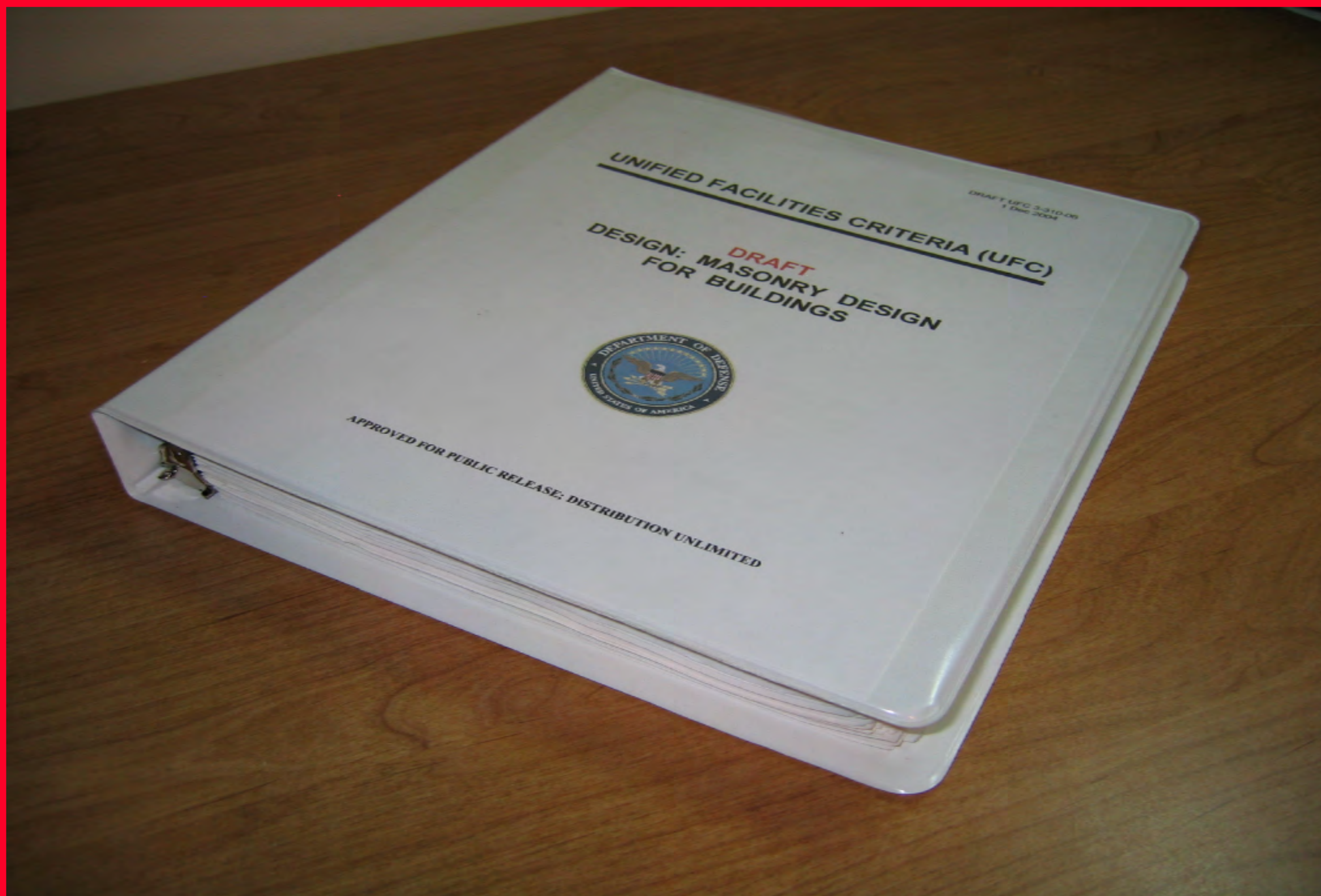
First Draft UFC

HEARTLAND ENGINEERS

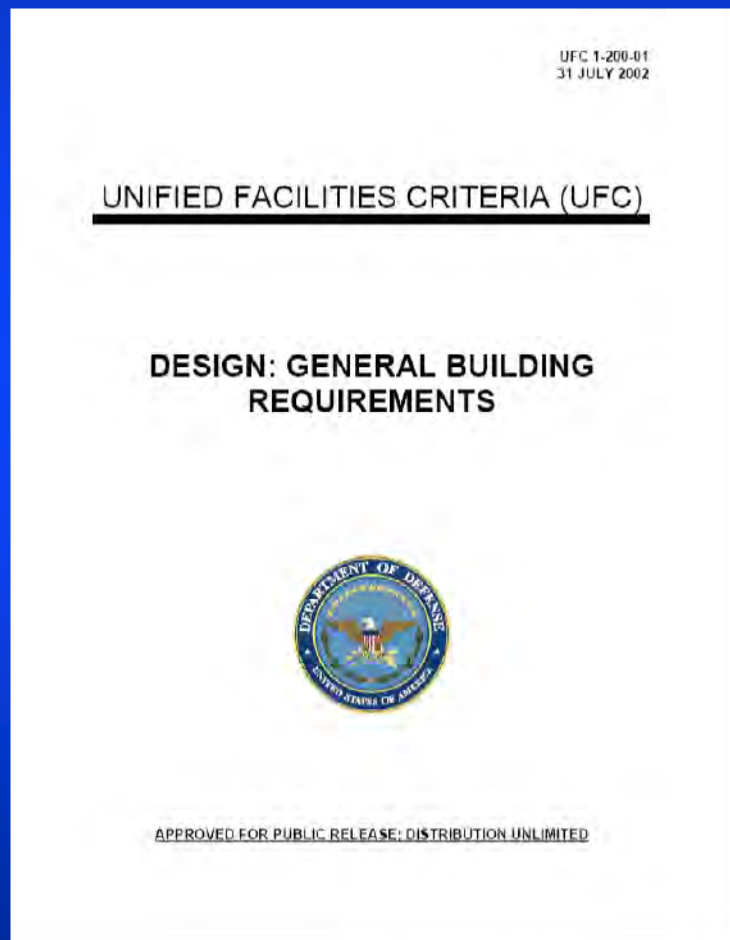
History of Masonry Criteria
Draft UFC 3-310-06

1. Introduction
2. Quality Control and Quality Assurance
3. Materials
4. Design for Crack Control
5. General Criteria for Reinforced Masonry
6. Reinforced Masonry Walls
7. Reinforced Shear Walls
8. Lintels
9. Columns and Pilasters
10. AT / FP for Masonry Buildings
11. Appendices A, B, C, and D (Design Aids for Walls, Lintels, Columns and Pilasters)

2nd Draft UFC 3-310-06



UFC 1-200-01
31 Jul 2002


UFC 1-200-01
31 JULY 2002

UNIFIED FACILITIES CRITERIA (UFC)

DESIGN: GENERAL BUILDING REQUIREMENTS

APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

UFC 1-200-01
31 Jul 2002

1-6.22 **Chapter 21 – MASONRY.**

- Use Chapter 21 and UFGS Division 4, Masonry. Chapter 21 supercedes Army TM 5-809-3, NAVFAC DM-2.9, AFM 88-3, Chapter 3, *Masonry Structural Design for Buildings*.
- Give special attention to control cracking in concrete masonry structures using the guidance contained in Tables 1-2 and Table 1-3. Because the Masonry Society has a waiver for use of metric products, brick and concrete masonry units (CMU) are normally not available in metric sizes.

UFC 1-200-01
31 Jul 2002

Table 1-2 Recommended Joint Control Spacing[a]

Vertical Spacing Of Joint Reinforcement With 2-#9 Wires[b] (in)	Maximum Ratio Of Panel Length To Wall Height (L/H)[c]	Maximum Spacing Of Control Joints [d] (ft)
None [e]	2	18
16	3	24
8	4	30

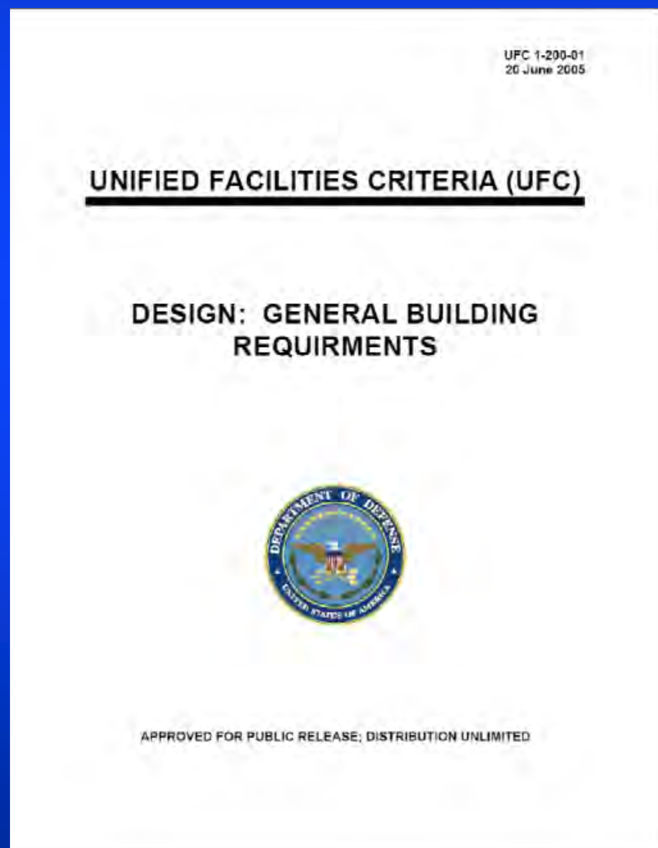
[a] Based on moisture-controlled, type I, concrete masonry in intermediate humidity conditions (ASTM C 90). The designer should adjust the control joint spacing for local conditions. The recommended spacing may be increased 6 ft in humid climates and decreased 6 ft in arid climates.
[b] Joint reinforcement will be cold-drawn deformed wire with a minimum 9-gauge longitudinal wire size.
[c] L is the horizontal distance between control joints. H is generally the vertical distance between structural supports.
[d] The spacing will be reduced approximately 50% near masonry-bonded corners or other similar conditions where one end of the masonry panel is restrained.
[e] Not recommended for walls exposed to view where control of cracking is important.

Table 1-3 Maximum Spacing of Vertical Expansion Joints in Brick Walls, $\Delta T=100^0F$

EXP.JT Width (in)	W x in	Max. Spacing of BEJs [a]
3/8	3/16	22
1/2	1/4	30
3/4	3/8	44
1 (MAX)	1/2	60

[a] Provide expansion joints at 6 to 10 ft from corners.
Recommended vertical BEJ locations.
a. At regular intervals as noted in table above.
b. At changes in wall height or thickness
c. Near wall intersections in "L", "T", and "U"-shaped buildings at approximately 6 to 10 ft) from corners.
d. At other points of stress concentration.
e. At edges of openings.

UFC 1-200-01
20 June 2005


UFC 1-200-01
20 June 2005

UNIFIED FACILITIES CRITERIA (UFC)

DESIGN: GENERAL BUILDING
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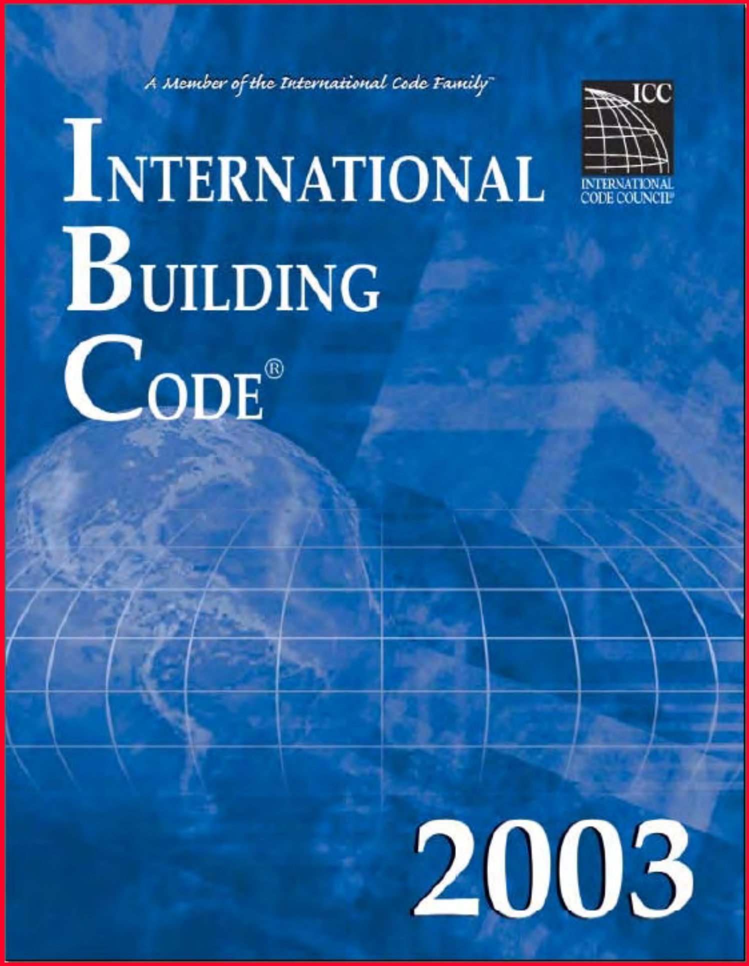
UFC 1-200-01
20 June 2005

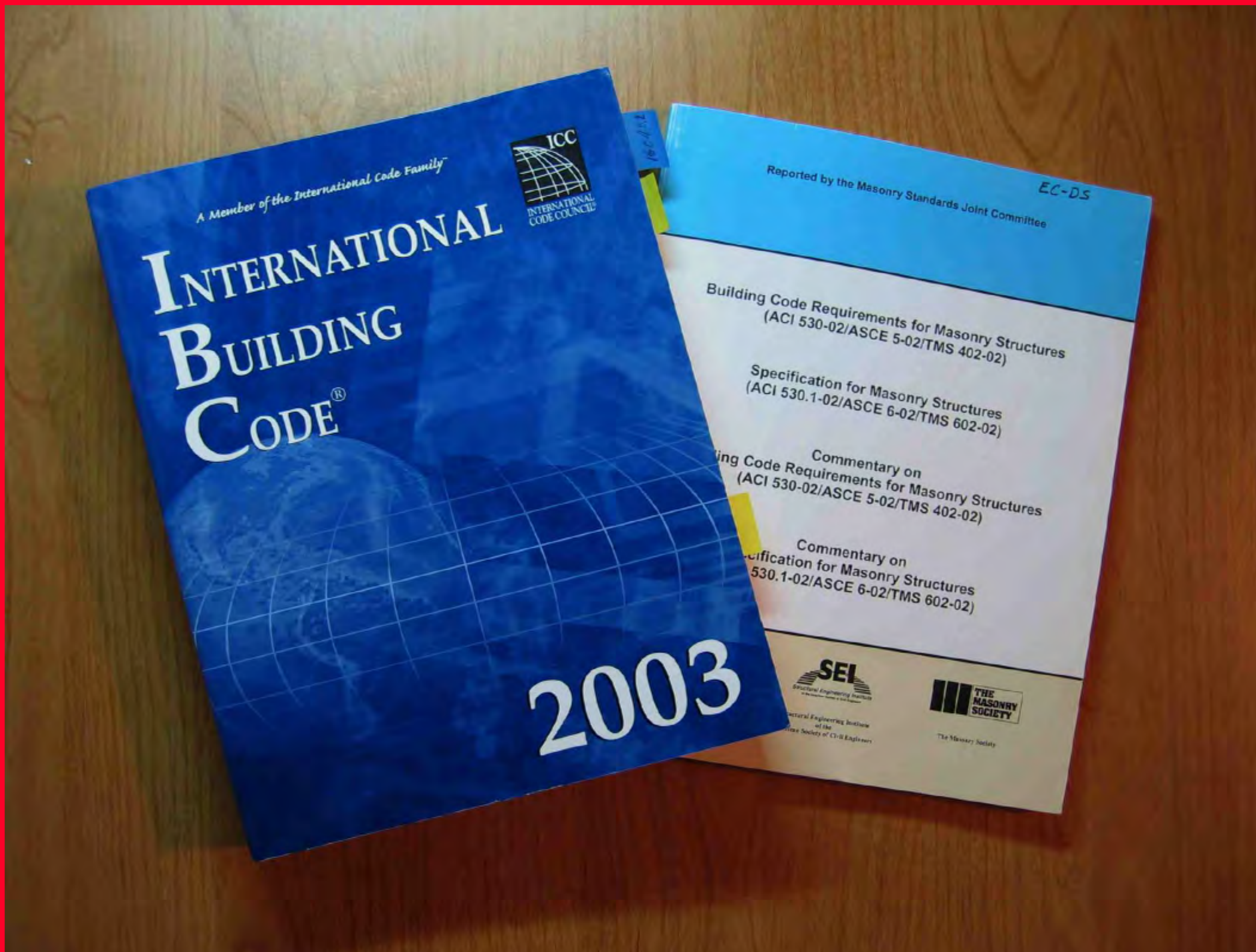


UFC 1-200-01
20 June 2005

"2-21 CHAPTER 21 – MASONRY"

US Army Corps of Engineers
Kansas City District

UFC 1-200-01
Masonry: Use Chapter 21



Revised (Reduced) Draft UFC 3-310-06

IBC Exceptions

- Chapter 1 Introduction and General Discussion
- Chapter 2 Exceptions to the IBC
- 9 pages
  - Crack control – 4 pages
  - QC / QA – 2 pages

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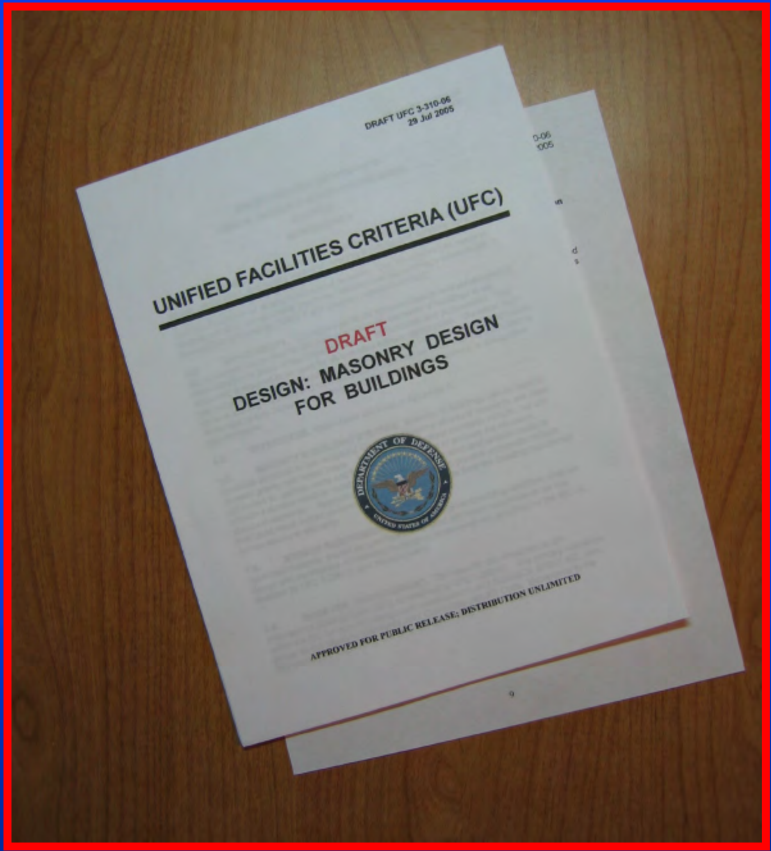
Kansas City District

Revised (Reduced) Draft UFC 3-310-06

- 9 Pages



IBC Exceptions (Proposed)

- Reinforced Masonry
- Design Method -- Strength Design for SDC C, D, E, and F
- Empirical Design not permitted
- Crack control criteria
- Quality Assurance

Reinforced Masonry

- All except non-structural masonry in SDC A
- Design Unreinforced Masonry per IBC (MSJC)
- Masonry veneer may be designed and detailed to meet the prescriptive requirements of ACI 530 Chapter 6 and design provision of IBC Chapters 14, 16 and 21.
- Maintain serviceability and crack control provisions
- Include reinforcement for AT/FP (UFC 4-010-01)

Design Method

- Use Strength Design method for all masonry structures in SDC C, D, E, and F.
- Working Stress (Allowable Stress) method permitted for SDC A and B only
- Empirical Design method is not permitted for DOD facilities
- Rational and prescriptive methods may be used for veneer and glass block.

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Crack Control
CMU - Vertical Control Joints

- Not covered by IBC
- Use NCMA TEK 10-3, CONTROL JOINTS FOR CONCRETE MASONRY WALLS – ALTERNATIVE ENGINEERED for vertical control joint spacing
- Aspect Ratio not to exceed 1.5
- Maximum spacing of 25 feet
- Reduce to ½ joint spacing at wall intersections, changes in wall height, and other stress concentration points

CMU Control Joints

Control Joint Spacing vs Aspect Ratio		
Aspect Ratio (Maximum ratio of panel length to wall height)(1)	**Vertical Spacing of Joint Reinforcement (inches)(2)**	**Maximum Control Joint Spacing (feet)(3,4)**
1.25	None (5)	16
1.5	16	25

(1) Length is the horizontal distance between control joints. Height is generally the vertical distance between structural supports.

(2) 2 9-gage wires @ 16in o.c. = 0.0255 in^2 /ft.

(3) The designer should adjust the control joint spacing for local conditions. The recommended spacing may be increased 6 feet in humid climates and decreased 6

(4) The spacing will be reduced approximately 50% near masonry bonded corners or other similar conditions where one end of the masonry panel is restrained

(5) Not recommended for walls exposed to view where control of cracking is important.

Note: Recommendations are for any type of concrete units. Moisture controlled units have been eliminate from ASTM C90.

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Crack Control
Brick Expansion Joints

VERTICAL JOINTS SPACING and SIZE
(horizontal expansion)

- Compute unrestrained expansion
  - $W_x = [\varepsilon_A + \varepsilon_T(\Delta T)](L)$
- Joint width = 2 x W_x

CLAY BRICK
VERTICAL EXPANSION JOINT SPACING

Expansion Joint Width (inches)	Total Brick Expansion W_x (inches)	Max. Spacing of Brick Expansion Jts (feet)
3/8	3/16	22
1/2	1/4	30
3/4	3/8	44
1 (max)	1/2	60

Horizontal Brick Expansion Joint
(vertical expansion)

- Minimum of 3/8 inch wide
- Do not exceed height limits in ACI 530 Chapter 6
- Place horizontal BEJ
  - Under shelf angles
  - At each floor level of multi-story buildings
  - At points of vertical movement restraint

Quality Assurance

QA addressed in 3 areas:

- Quality Assurance Plans and Special Inspections
- Contractor Quality Control
- Structural Observations and Site Visits

Quality Assurance

- Quality Assurance Plans and Special Inspections
  - IBC:
    - QAP prepared by Design Professional working for the owner.
    - Design Professional or agent provides Special Inspections
  - Government:
    - QAP prepared by construction contractor
    - Construction contractor provides Special Inspections
    - Use UFGS (01452 and others)

Quality Assurance

- Contractor Quality Control
  - IBC:
    - Acknowledgement of special requirements
    - Acknowledgement that control will be exercised
    - Procedures for exercising control
    - Identification and qualifications of persons exercising control
  - Government:
    - CQC plan prepared by construction contractor (UFGS 01451A)
    - DQC plan prepared by construction contractor for Design-Build contracts (UFGS 01451A)

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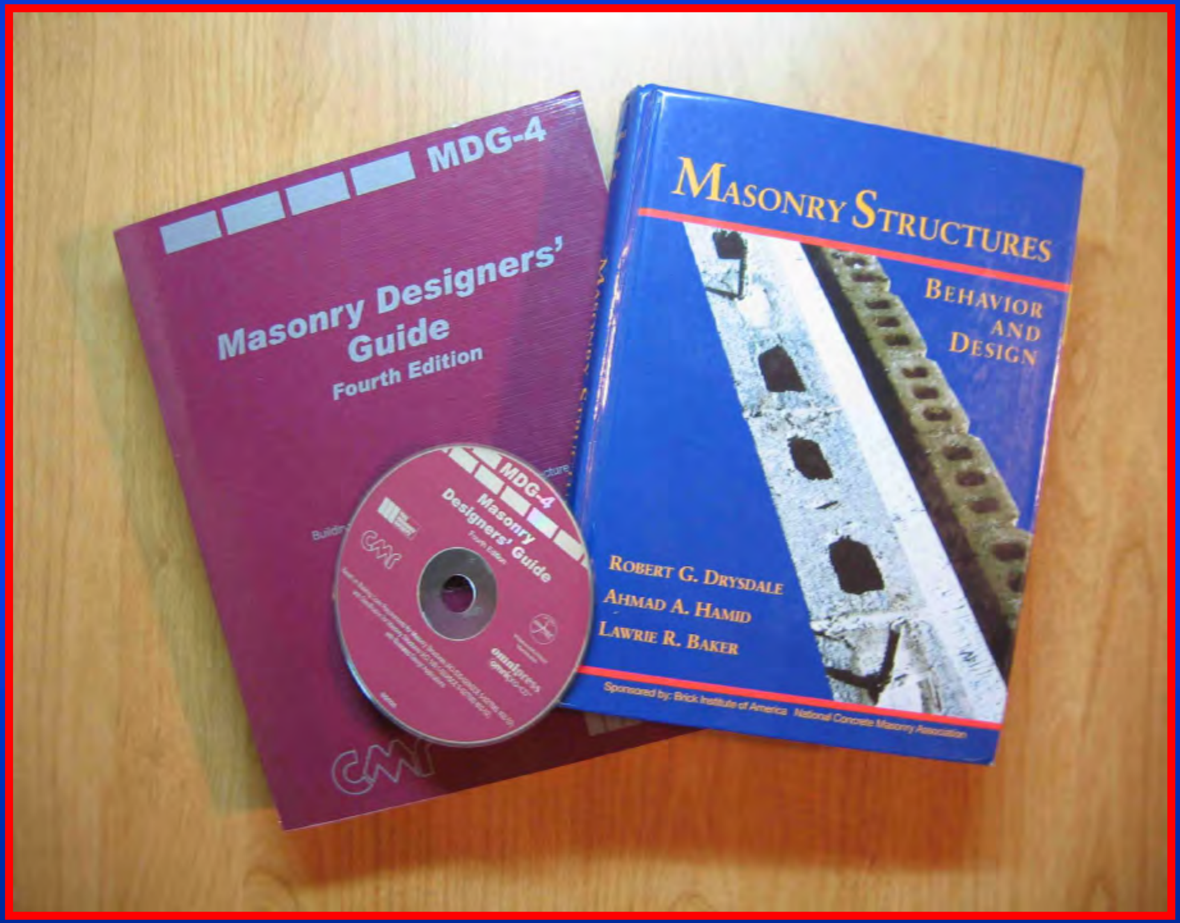
Quality Assurance

- Structural Observations
  - IBC:
    - Required for select structural systems
    - Required to be done by the Registered Design Professional
  - Government:
    - Required for select structural systems
    - Required to be done by the Registered Design Professional

Where should you go for guidance?



QUESTIONS

Seismic Stress Analysis of Folsom Dam

Rick L. Poeppelman (USACE Sacramento District)
Chung F. Wong (USACE Sacramento District)
Enrique E. Matheu (USACE Engineer Research and Development Center)
Michael Ma (USACE Sacramento District)

Presented by
Enrique E. Matheu, PhD
Geotechnical and Structures Laboratory
Engineer Research and Development Center
Vicksburg, MS

2005 Tri-Service Infrastructure Systems Conference and Exhibition
St. Louis, MO – August 2-4, 2005

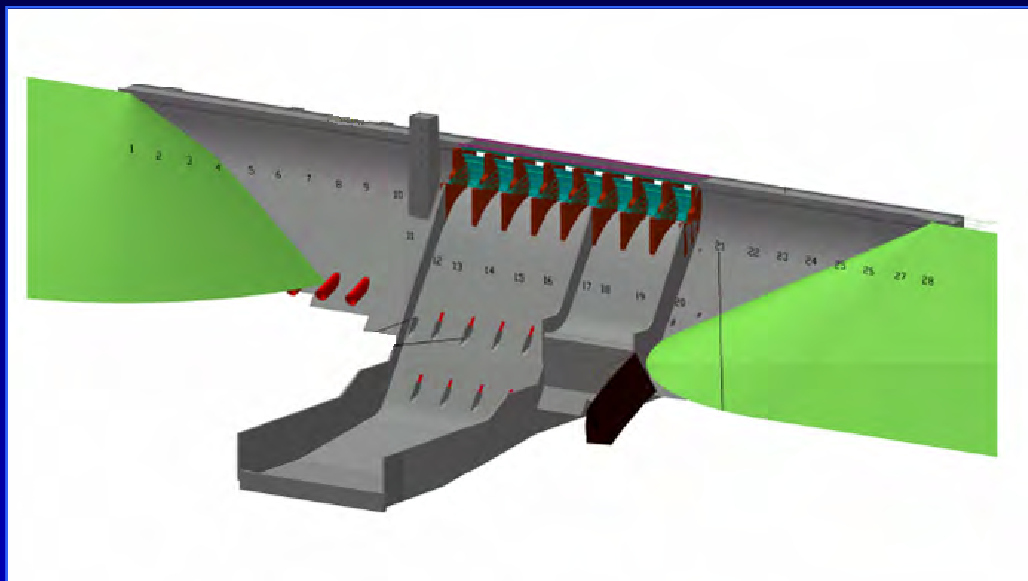
Introduction

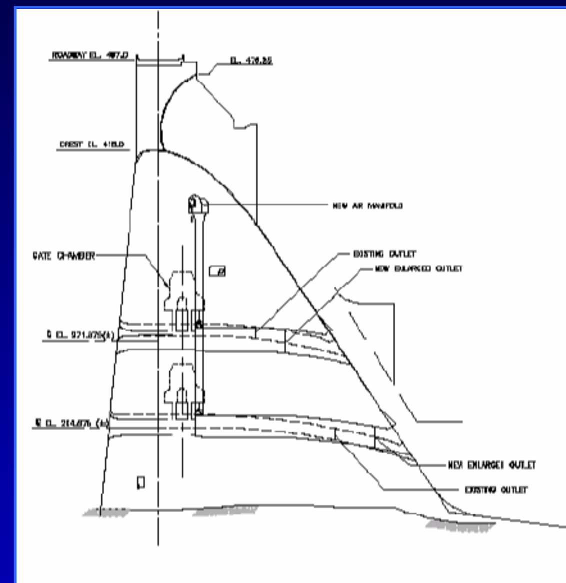
- **Folsom Dam Description**

  - Design/construction by USACE (1948-1956), transferred to USBR (1956)
  - Maximum height of gravity section is 340 ft with a crest length of about 1,400 ft.
  - 28 monoliths, 50 ft wide each.
  - Main spillway: 5 ogee monoliths, two tiers of 4 outlets. Emergency spillway: 3 flip bucket monoliths.
  - Embankment wrap fill and wing dams

Introduction

- **Outlet Works Modification Project**

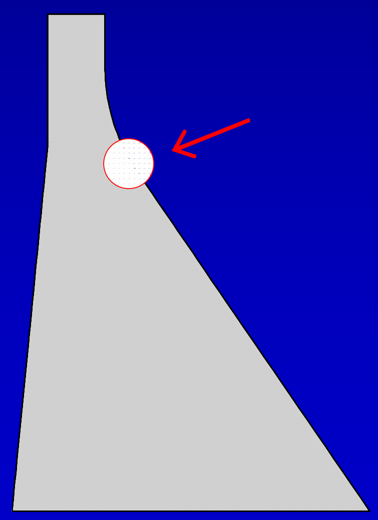




- Project will increase the river outlet release capacity from 26,000 cubic feet per second to 115,000 cubic feet per second.
- Spillway section modifications basically consist of enlarging the four existing upper tier river outlets (9.33 ft by 14 ft), constructing two new upper tier river outlets of the same size, and enlarging the four existing lower tier river outlets (9.33 ft by 12 ft).

Previous Stress Analyses

- DSAP Evaluation
  - DSAP seismic evaluation completed in 1989.
  - Peak ground acceleration (PGA) for the horizontal direction defined as 0.35g.
  - Analyses performed using the computer program EAGD-84, considering the tallest non-overflow monolith as critical section.
  - Different values of foundation modulus (5.8, 7.9, and 11.0 10^6 psi) and wave reflection coefficient (0.75, 0.79, and 0.82) were considered.
  - Maximum principal stresses reached about 870 psi on the downstream face, near the lower end of the circular transition.



Previous Stress Analyses

- DSAP Evaluation

Concrete Material Properties

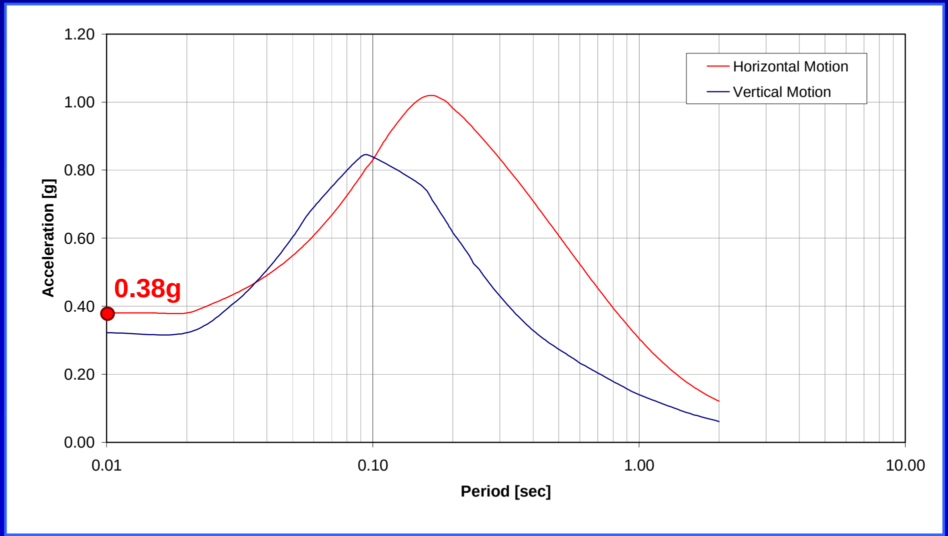
Modulus of Elasticity Dynamic (10^6 psi)	Poisson's Ratio	Unit Weight (pcf)
5.9	0.19	158

Foundation Rock Properties

Modulus of Elasticity Dynamic (10^6 psi)	Poisson's Ratio	Unit Weight (pcf)
5.8	0.30	167
7.9	0.25	171
11.0	0.20	174

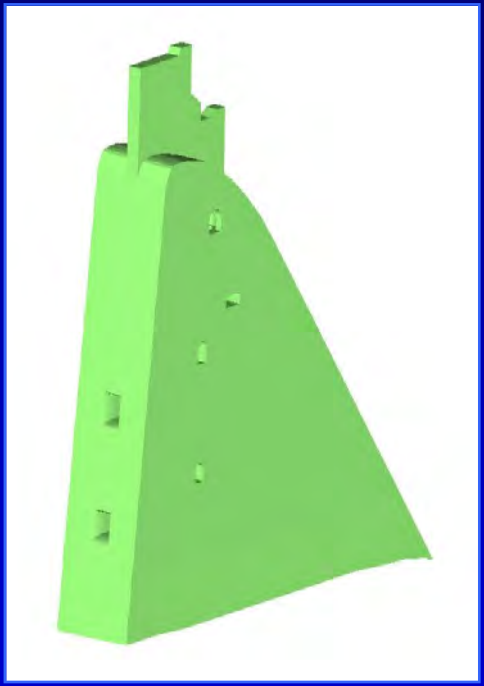
Ground Motions

- **Maximum Credible Earthquake**
  - **Event of magnitude 6.5 at a source-to-site distance of 14 km, on the eastern branch of the Bear Mountains fault zone.**
  - **Horizontal PGA values corresponding to the 50th and 84th percentile were determined as 0.24g and 0.38g, respectively.**
  - **Vertical response spectrum defined using a period-dependent scaling factor.**



Response-Spectrum Based Analyses

- Approach
  - 3D GTSTRUDL FE mesh of 50-ft wide dam monoliths.
  - Chopra's simplified procedure used to develop sets of lateral forces .
  - Horizontal and vertical components of input motion.
  - Peak dynamic responses obtained by combination using SRSS rule.
  - Dynamic responses combined with static results (monolith weight, hydrostatic pressures, and uplift).
  - Results used for design of reinforced concrete liners.

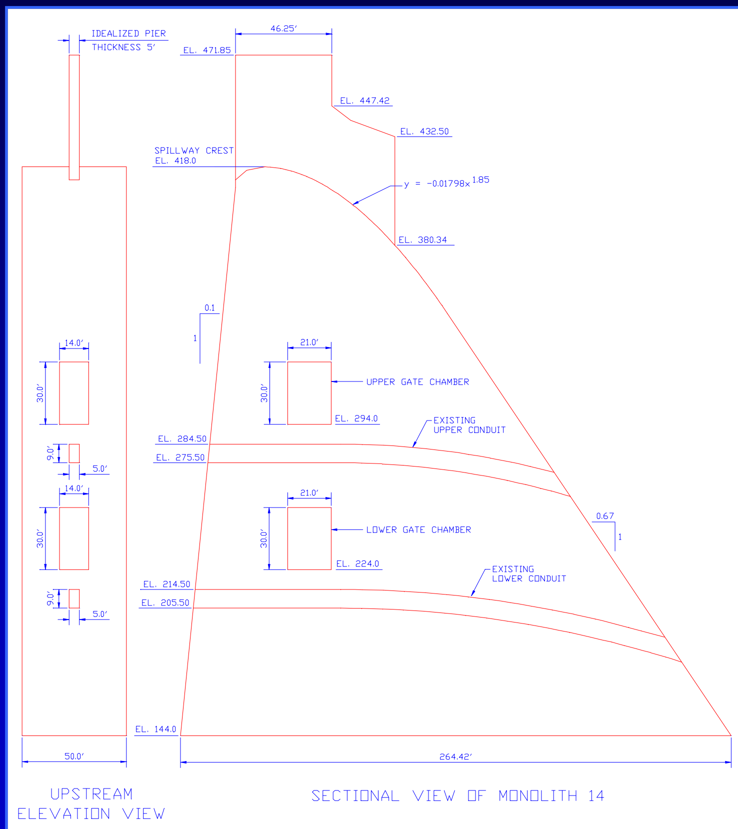


Response-Spectrum Based Analyses

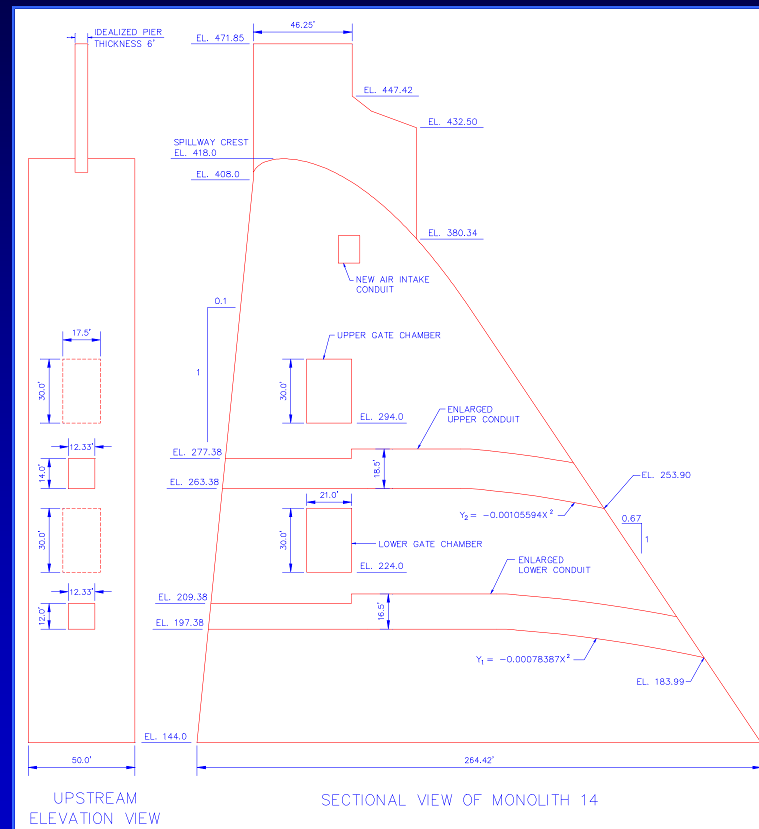
- **Chopra's Simplified Procedure**
  - Dynamic response can be described by the fundamental mode of vibration of the dam on rigid foundation rock.
  - Mode shape does not take into account foundation flexibility.
  - Analysis of fundamental-mode response still a complex problem because of frequency-dependent interaction phenomena (dam/reservoir, dam/foundation).
  - By defining frequency-independent parameters, an equivalent SDOF system is used to approximate the dynamic response.
  - FE analysis conducted using sets of lateral forces representing inertial and hydrodynamic actions associated with fundamental-mode including higher-mode correction.

Response-Spectrum Based Analyses

- Evaluation of Different Conditions



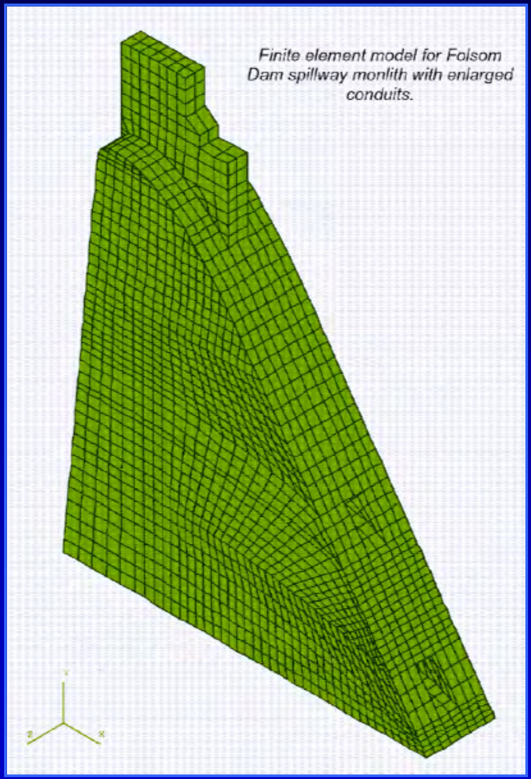
Monolith 14
Existing condition



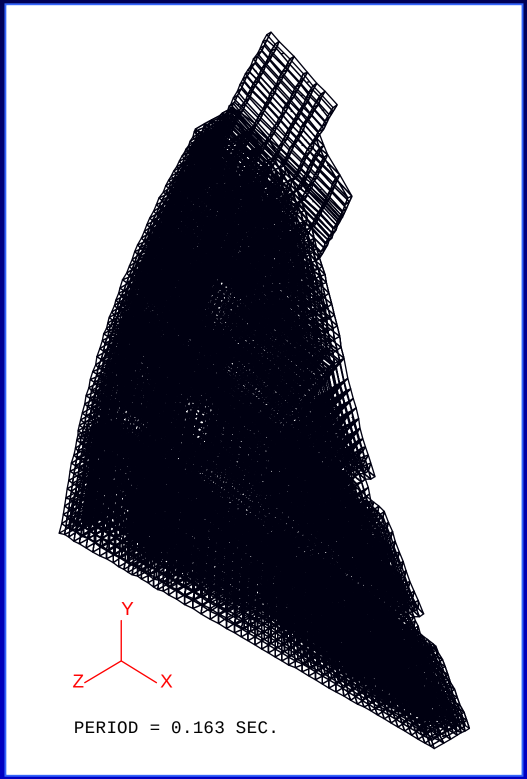
Monolith 14
Modified condition

Response-Spectrum Based Analyses

- **Finite Element Model**



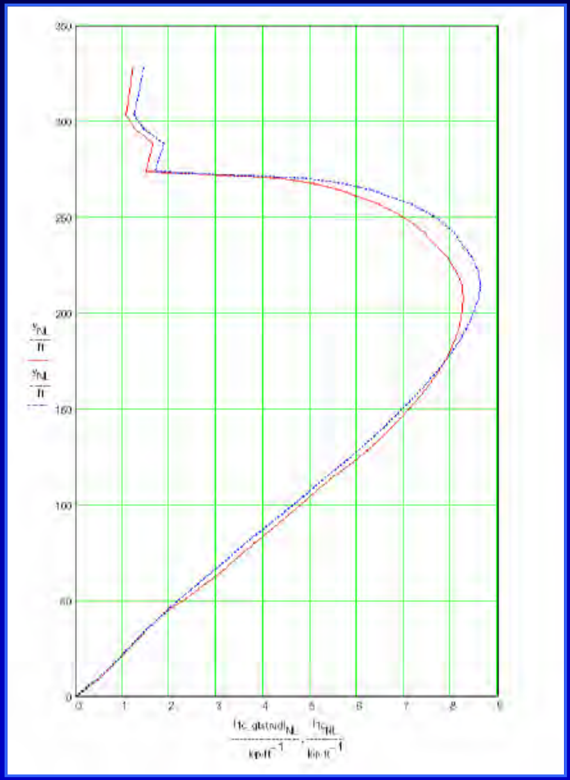
3D model



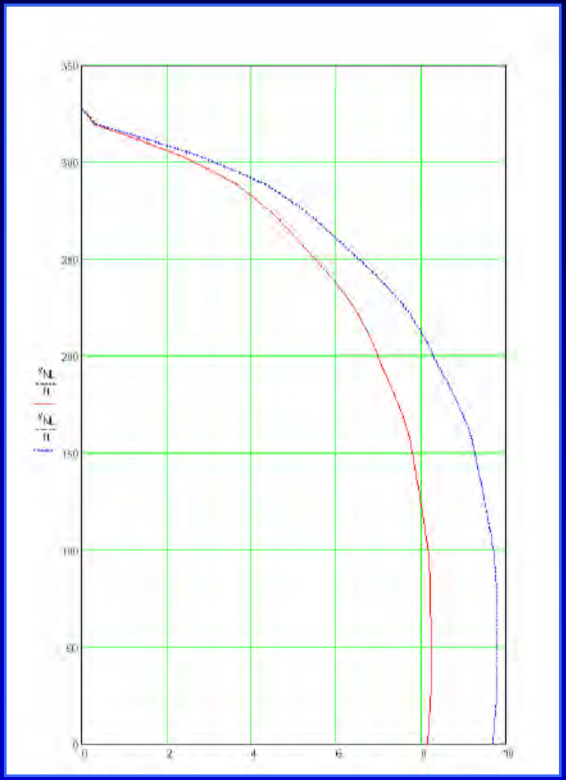
Fundamental mode shape
T_1 = 0.163 sec (f_1 = 6.14 Hz)

Response-Spectrum Based Analyses

- Equivalent Forces – Fundamental Mode



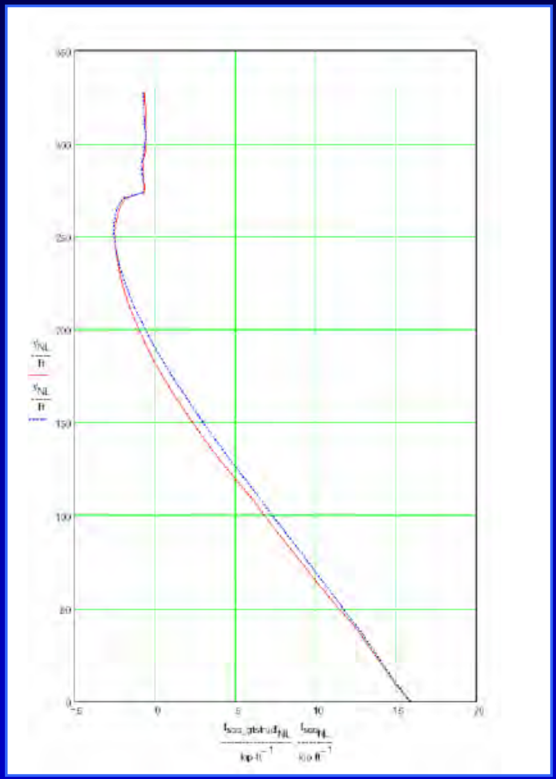
Inertia forces associated with fundamental mode response



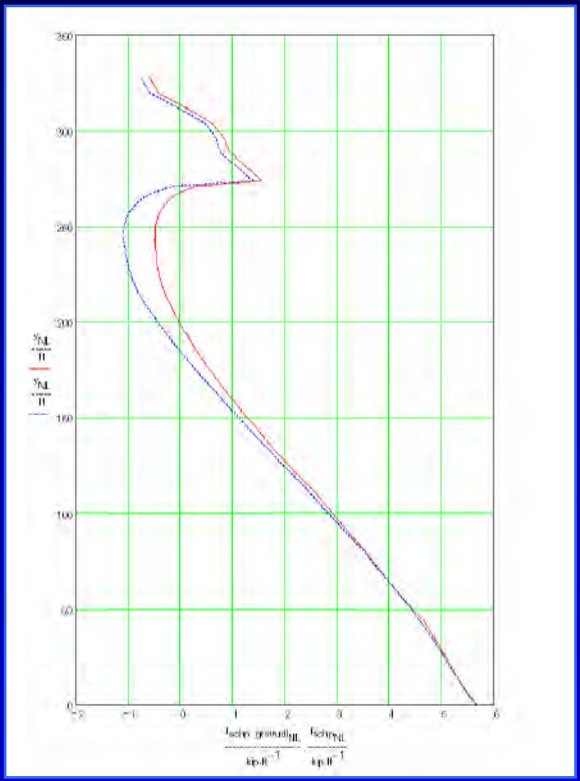
Hydrodynamic forces associated with fundamental mode response

Response-Spectrum Based Analyses

- **Equivalent Forces – Higher-Mode Correction**



Inertia forces associated with higher-mode contributions



Hydrodynamic forces associated with higher-mode contributions

Response-Spectrum Based Analyses

- Cases Analyzed

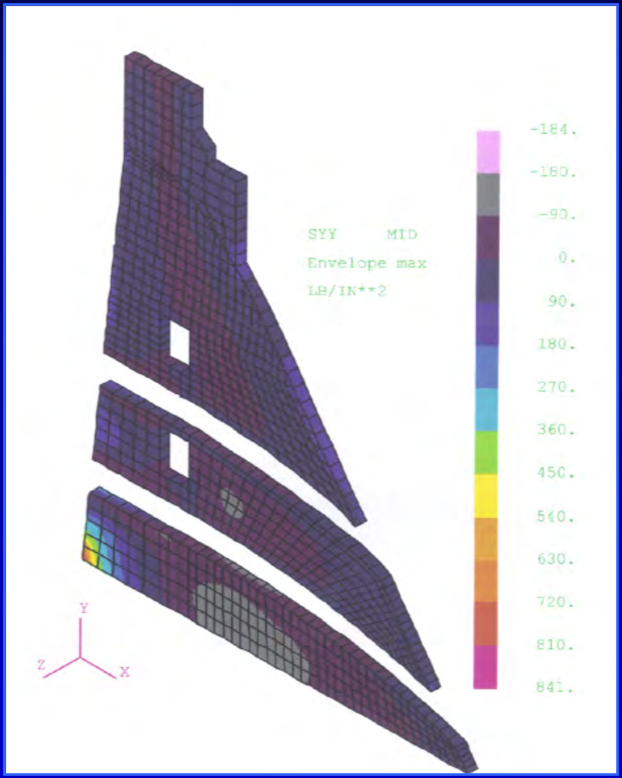
TABLE 4 SUMMARY OF CASES ANALYZED

Case No.	Monolith	Condition	Modulus of Elasticity of Concrete E_s (psi)	Modulus of Elasticity of Foundation Rock E_f (psi)	Earthquake
1	14	Existing	3.6×10^6	Rigid	-
2	14	Modified	3.6×10^6	Rigid	-
3	14	Existing	5.9×10^6	7.9×10^6	MCE
4	14	Modified	5.9×10^6	7.9×10^6	MCE
5	13	Existing	3.6×10^6	Rigid	-
6	13	Modified	3.6×10^6	Rigid	-
7	13	Existing	5.9×10^6	7.9×10^6	MCE
8	13	Modified	5.9×10^6	7.9×10^6	MCE

Response-Spectrum Based Analyses

- **Evaluation of Peak Stresses**

  - Results for Monolith 14 showed peak vertical tensile stresses mostly within the apparent dynamic tensile strength (700 psi)
  - Stress concentration (1,140 psi) at the upstream heel but stress values drop sharply within 10 ft.
  - The results for Monolith 21 also indicated stress concentration at the upstream heel (890 psi).



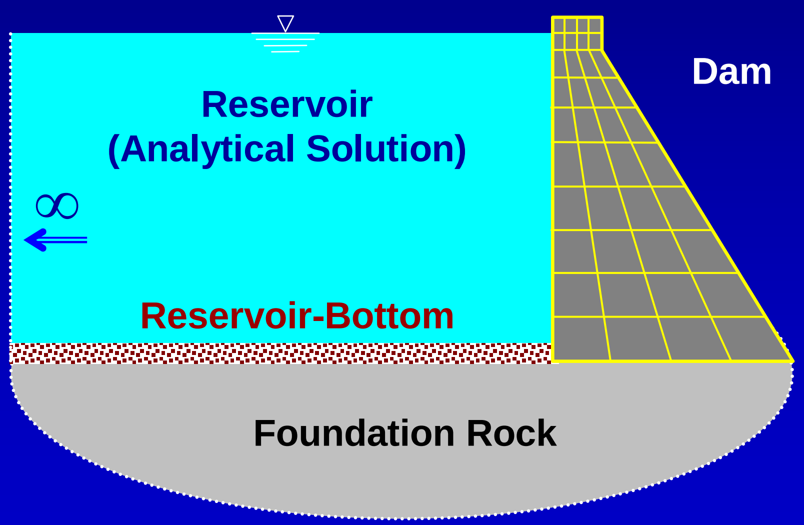
Envelope of maximum normal stresses Syy (psi) at z = 25 ft

Time History Analyses

- Approach
  - Seismic stress analyses were conducted on 2D FE models of monoliths 14 and 21, subject to ground motion time histories representative of the MCE.
  - Analyses performed with the computer program EAGD-84.
  - Program developed at the University of California at Berkeley (Fenves and Chopra, 1984) to evaluate the seismic response of two-dimensional sections of concrete gravity dams taking into account
    - Dam-water interaction
    - Dam-foundation rock interaction
    - Energy absorption at the bottom of the reservoir

Time History Analyses

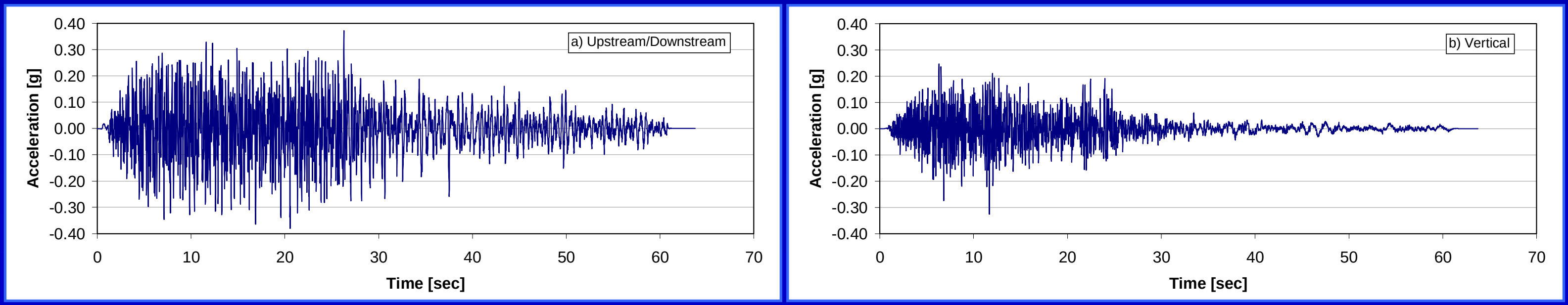
- **Program EAGD-84**
  - Equations of motion solved in the frequency domain assuming linear behavior for the dam-water-foundation system.
  - The foundation region idealized as a homogeneous, isotropic, viscoelastic half-plane.
  - Reservoir modeled as fluid domain of constant depth and infinite length along the upstream direction.
  - Energy absorption associated with reservoir bottom materials quantified by wave reflection coefficient (α).



Ground Motion Time Histories

- ## Maximum Credible Earthquake

Earthquake	Mw	Recorded ground motions				Modified time histories		
		Station	Dist. (km)	Comp.	PGA (g)	PGA (g)	PGV (cm/sec)	Direction
1971 San Fernando	6.6	Pasadena – Old Seism. Lab.	19	180	0.09	0.38	27.0	Cross Ch.
				270	0.20	0.38	34.8	Us/Ds
				Vertical	0.09	0.30	13.5	Vertical
1979 Imperial Valley	6.5	Cerro Prieto	26	147	0.17	0.38	23.8	Us/Ds
				237	0.16	0.38	23.1	Cross Ch.
				Vertical	0.21	0.33	11.5	Vertical
1986 Chalfant Valley	6.2	Bishop – Paradise Lodge	23	70	0.16	0.38	28.8	Cross Ch.
				160	0.16	0.38	29.4	Us/Ds
				Vertical	0.13	0.31	11.7	Vertical



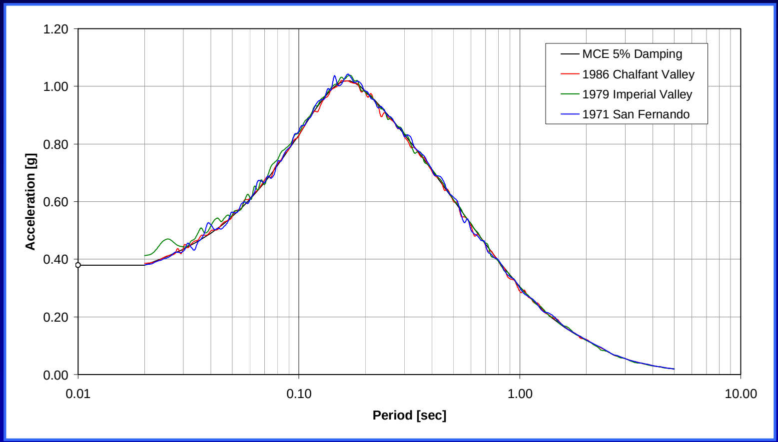
Imperial Valley Earthquake

US Army Corps of Engineers

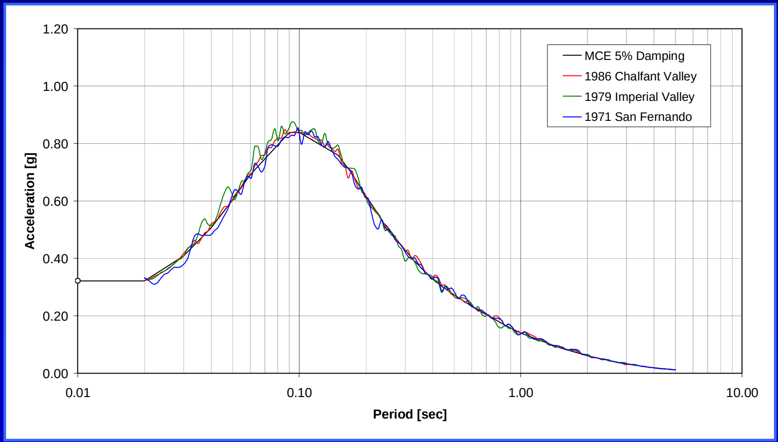
U.S. Army Engineer Research and Development Center

Ground Motion Time Histories

- Spectral Matching



Comparison of 5%-damped horizontal response spectra for truncated (30 sec) time histories



Comparison of 5%-damped vertical response spectra for truncated (30 sec) time histories

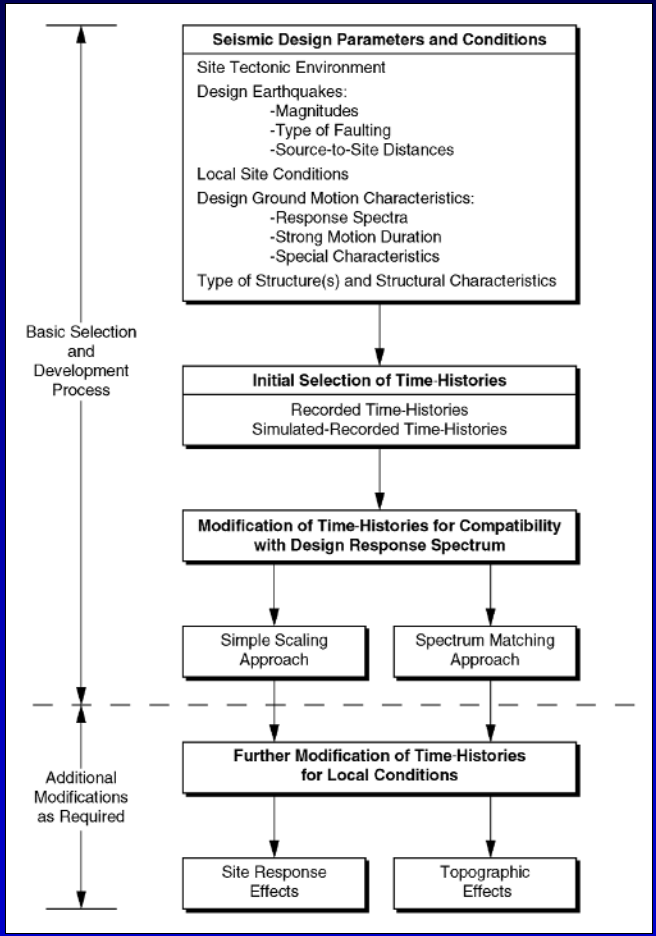
Ground Motion Time Histories

- **Response Spectrum Compatibility**
  - **Simple scaling approach:**

    At least three time-histories for each component of motion should be considered.

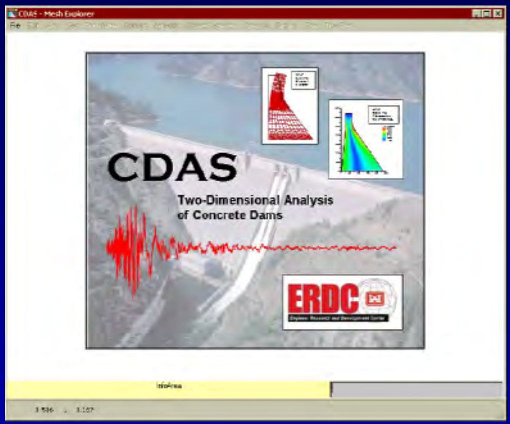
  - **Spectrum-matching approach:**

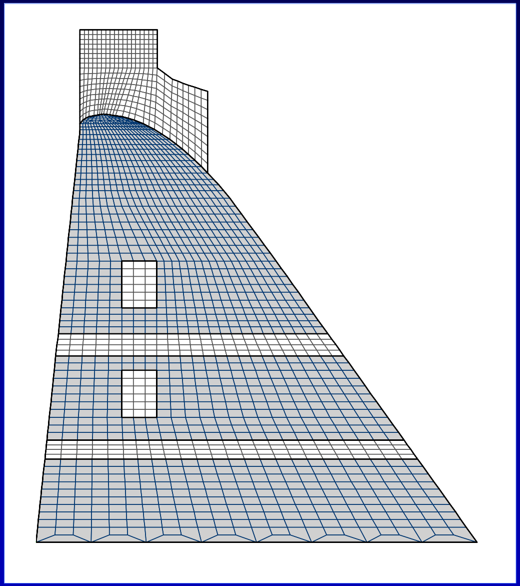
    Linear response is mainly determined by the spectral content of the time-history. If a very close fit to the target spectrum can be obtained, *a single time-history for each component may be sufficient*.



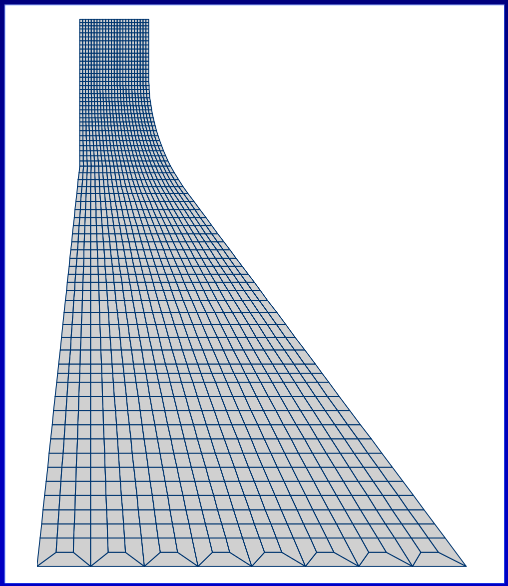
Time History Analyses

- 2D FE Models (EAGD-84)





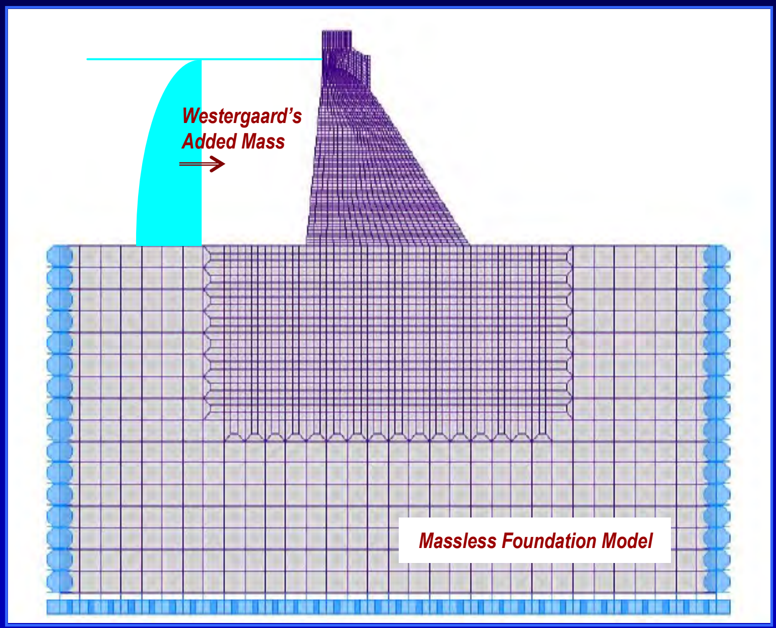
Finite-element mesh for spillway Monolith 14



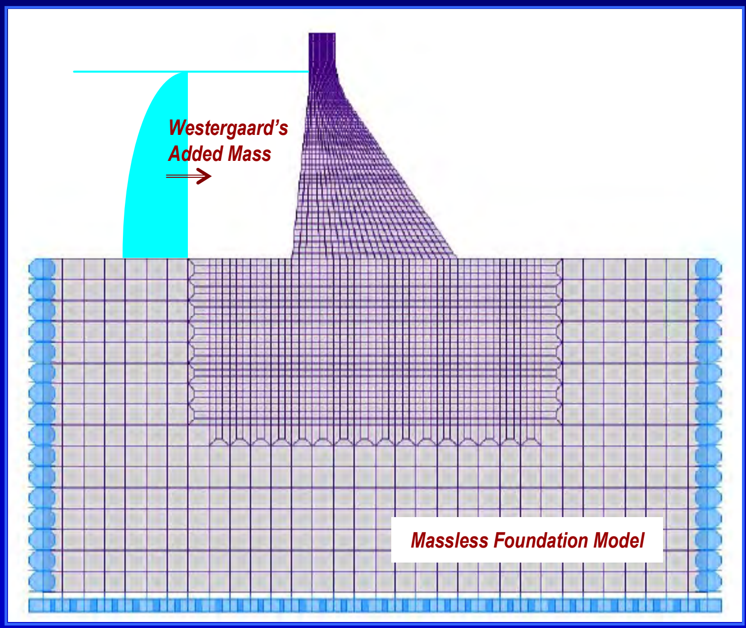
Finite-element mesh for non-overflow Monolith 21

Time History Analyses

- 2D FE Models (SAP2000)



Finite-element mesh for spillway Monolith 14



Finite-element mesh for non-overflow Monolith 21

Time History Analyses

- **Comparison of Natural Periods (2D Models)**

MODE	EAGD84 PERIOD [sec]		SAP2000 PERIOD [sec]	
	Rigid	Flexible	Rigid	Flexible
1	0.160	0.222	0.157	0.214
2	0.071	0.139	0.070	0.107
3	0.066	0.098	0.065	0.092
4	0.044	0.054	0.043	0.052
5	0.032	0.041	0.031	0.039

Monolith 14
(Empty reservoir)

3D Model: T_1 = 0.163 sec

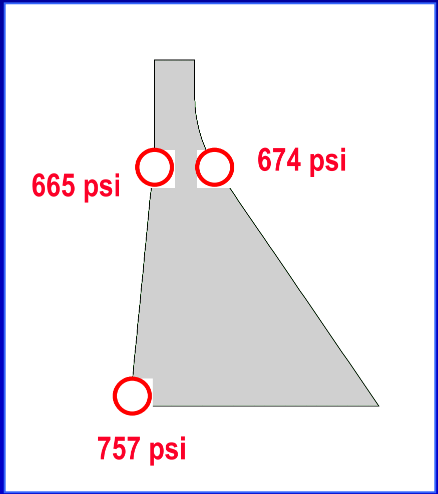
Monolith 21
(Empty reservoir)

MODE	EAGD84 PERIOD [sec]		SAP2000 PERIOD [sec]	
	Rigid	Flexible	Rigid	Flexible
1	0.184	0.221	0.184	0.215
2	0.083	0.101	0.083	0.106
3	0.059	0.088	0.059	0.088
4	0.044	0.056	0.044	0.058
5	0.029	0.037	0.029	0.036

Time History Analyses

- **Peak Values of Maximum Principal Stress**

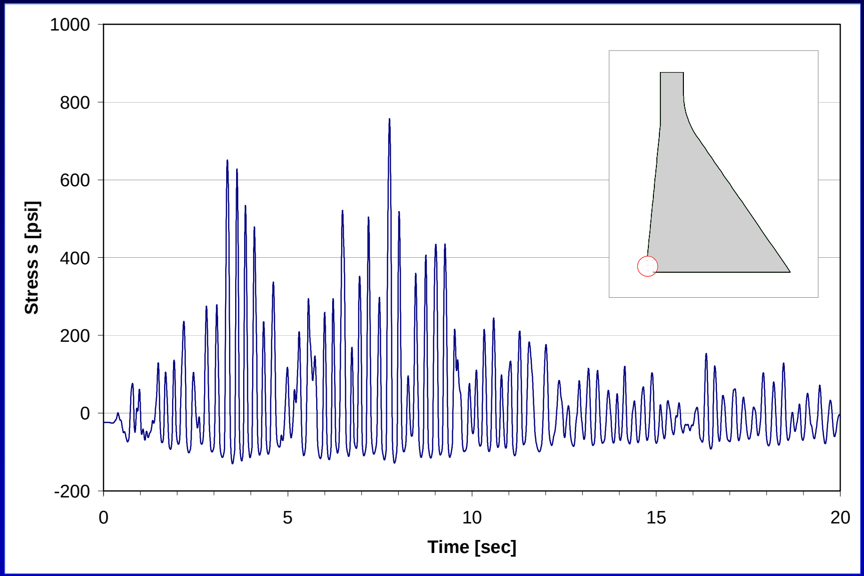
Monolith 21
San Fernando Earthquake
Reservoir pool elevation 466 ft



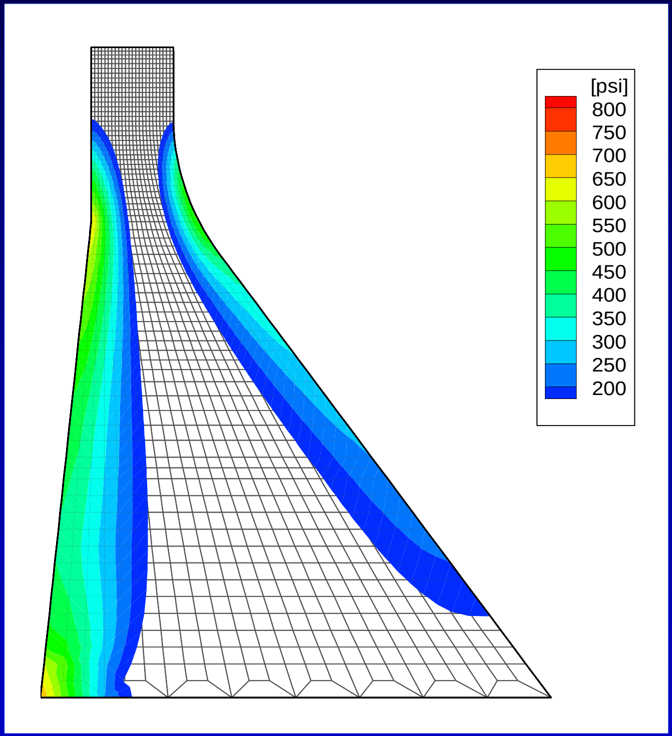
Case	Location	X [ft]	Y [ft]	Time [sec]	σ_{max} [psi]
+H	Base (Heel)	4.85	8.75	7.8	603
+H	Upstream	20.53	196.31	3.4	581
+H	Downstream	61.87	196.31	7.9	604
-H	Base (Heel)	4.85	8.75	3.5	606
-H	Upstream	20.53	196.31	7.9	597
-H	Downstream	63.64	192.92	3.4	593
+H+V	Base (Heel)	4.85	8.75	8.5	571
+H+V	Upstream	20.53	196.31	3.4	613
+H+V	Downstream	61.87	196.31	5.4	598
+H-V	Base (Heel)	4.85	8.75	7.8	757
+H-V	Upstream	20.53	196.31	3.9	665
+H-V	Downstream	63.64	192.92	7.9	641
-H+V	Base (Heel)	4.85	8.75	3.5	717
-H+V	Upstream	20.53	196.31	7.9	623
-H+V	Downstream	61.87	196.31	3.9	674
-H-V	Base (Heel)	4.85	8.75	5.4	618
-H-V	Upstream	20.53	196.31	7.9	579
-H-V	Downstream	60.45	199.25	5.5	616

Time History Analyses

- Stress Time Histories and Stress Contours



Maximum Principal Stress S_1

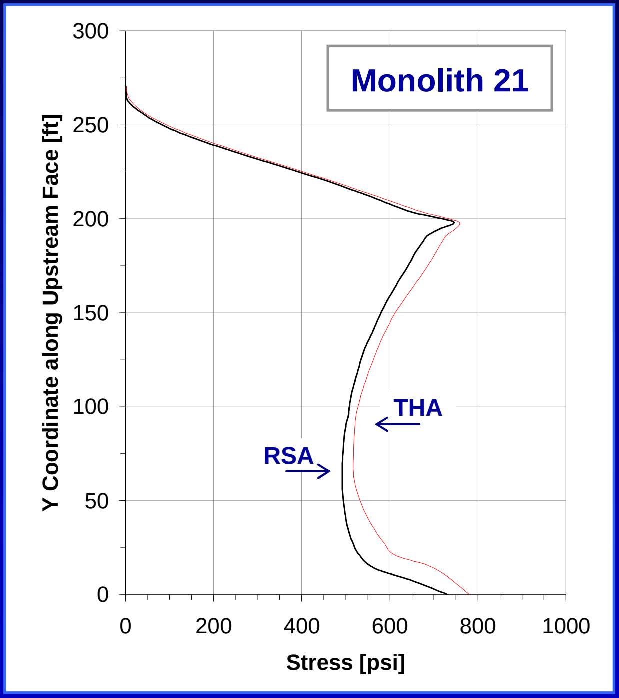


Normal Vertical Stress S_{yy}
(S_{yy} > 200 psi)

Monolith 21
San Fernando Earthquake +H/-V
Reservoir pool elevation 466 ft

Time History Analyses

- **Comparison with Response Spectrum Approach**



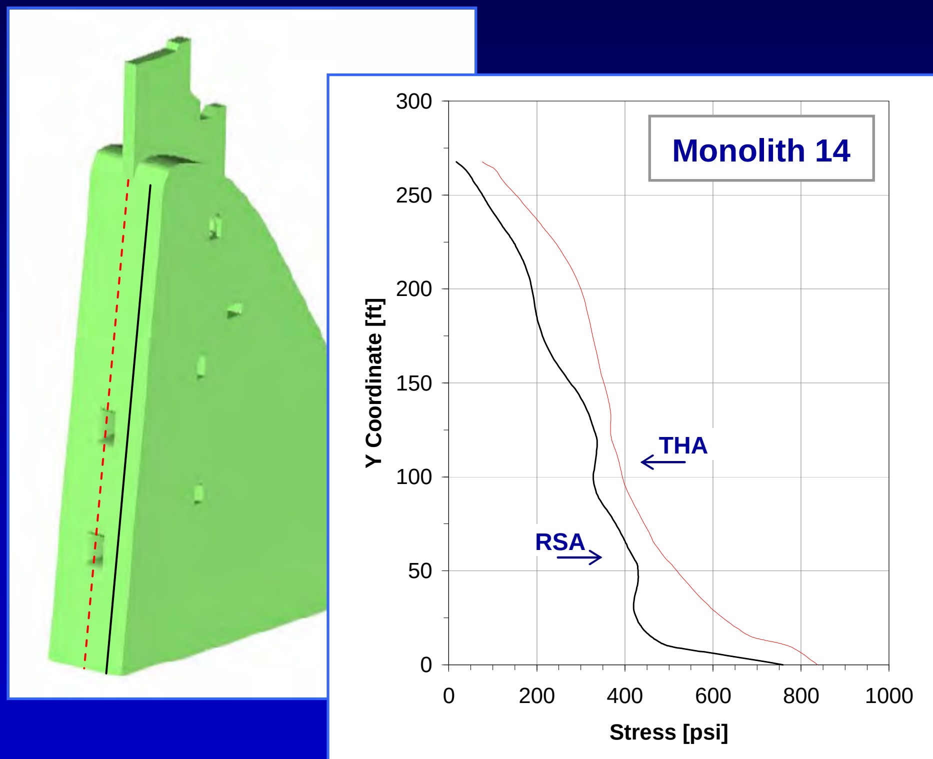
RSA → Maximum stress estimate obtained with the response spectrum approach considering horizontal and vertical input ground motion.

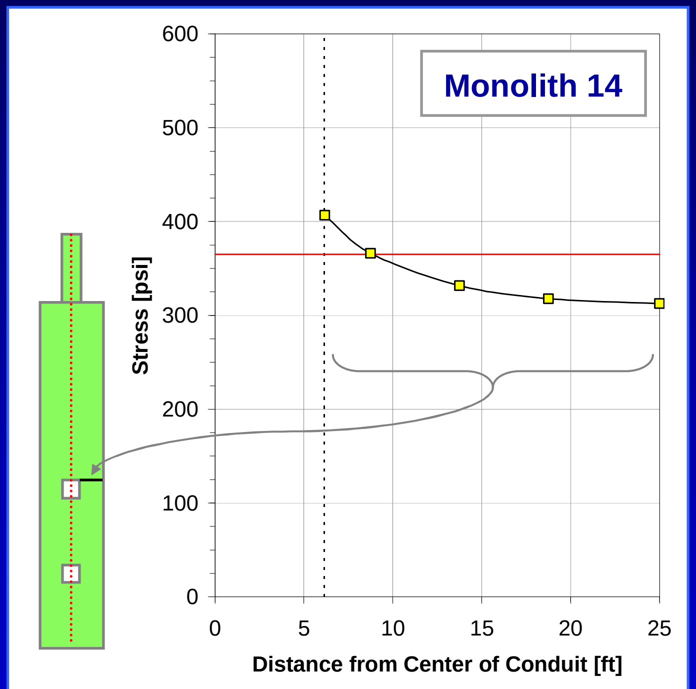
THA → Peak value of dynamic stress time history considering both components of the Imperial Valley Earthquake (combination –H/-V).

Distribution of maximum values of dynamic normal vertical stress along upstream face

Time History Analyses

- Comparison with Response Spectrum Approach





Distribution of maximum values of dynamic normal vertical stresses along upstream face

Summary

- Dynamic stress analyses of concrete gravity sections of Folsom Dam conducted using different approaches and considering horizontal and vertical ground motion components.
- Modified (expanded) version of Chopra's single-mode response-spectrum based procedure implemented for 3D FE analyses.
- 2D FE time history validation using EAGD-84, whose analytical formulation is consistent with the previous procedure (hydrodynamic effects, reservoir-bottom absorption, dam-foundation interaction).
- Some regions with tensile excursions above the assumed strength threshold (700 psi) were identified in Monoliths 14 and 21 but they were confined to areas with significant stress gradients and limited to the region immediately near the heel.

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Nonlinear Incremental Thermal Stress Strain Analysis Portugues Dam

Thermal Analysis Project Team

David Dollar Project Manager (USACE, Jacksonville District)
Ahmed Nisar (MMI Engineering)
Paul Jacob (MMI Engineering)
Charles Logie (MMI Engineering)

2005 Tri-Services Infrastructure Conference August, 2005

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US Army Corps of Engineers®
Jacksonville District

Objectives of Study

- Long term stable temperature response
- Location and behavior of contraction joints
- Potential for cracking
- Significance of material properties

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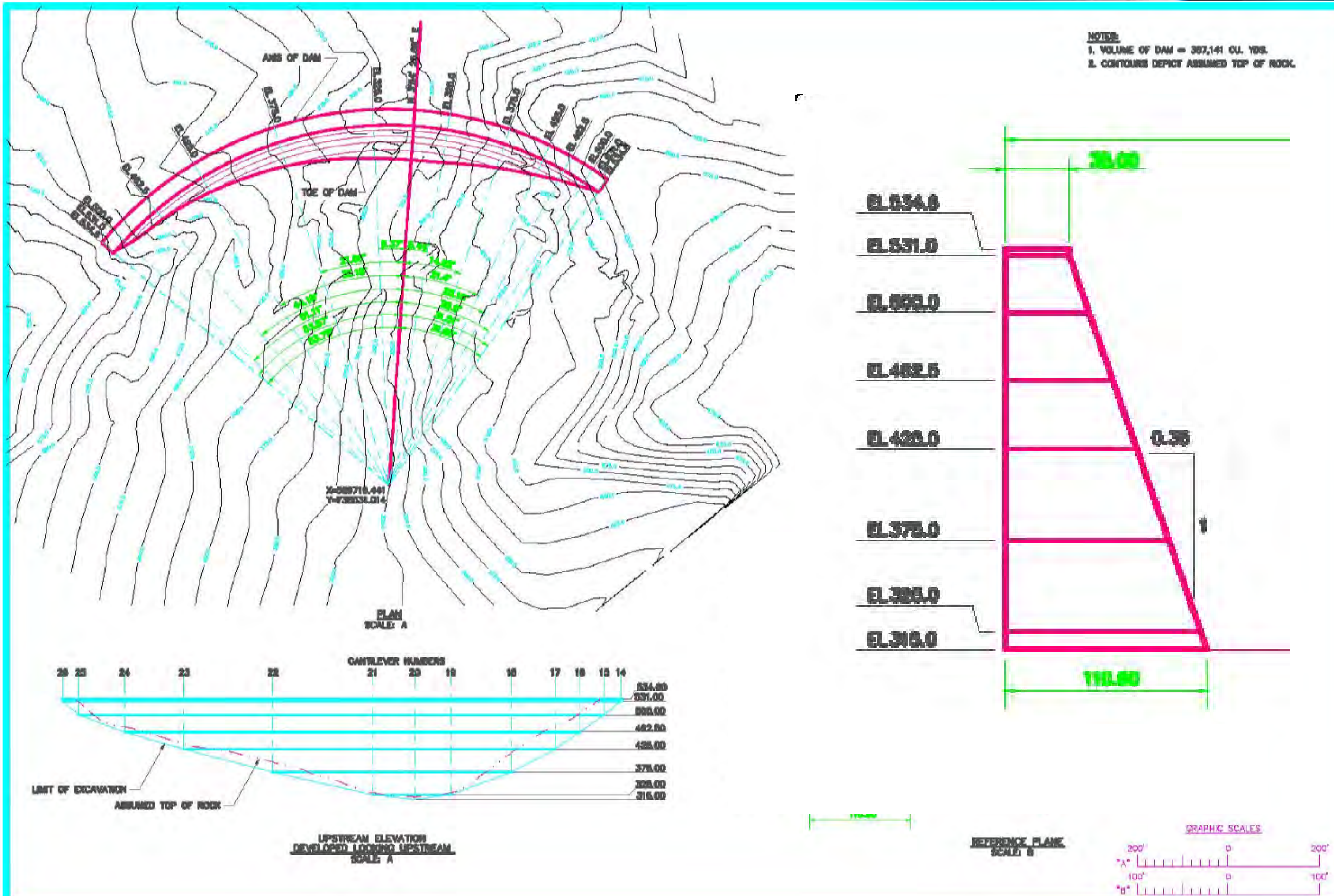
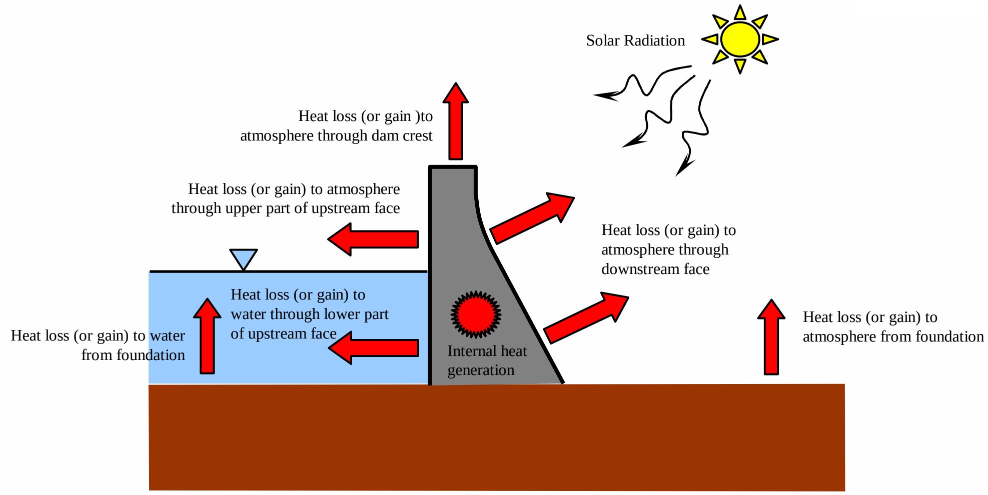


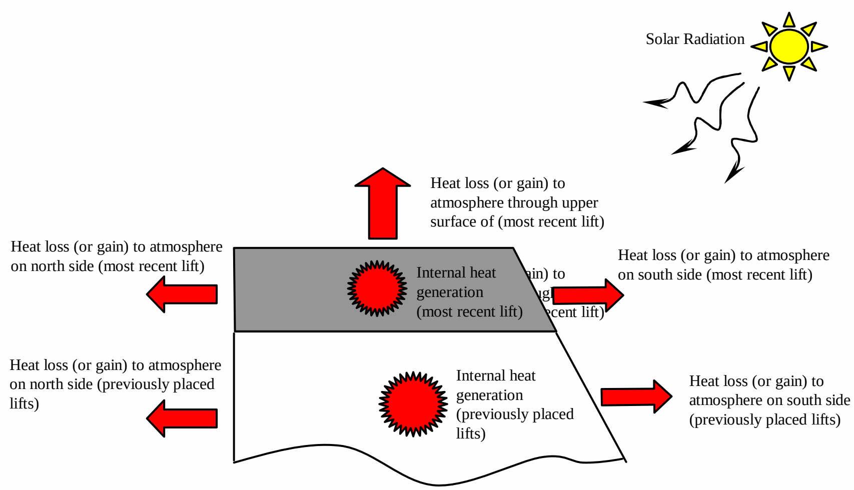
NOTES:
1. VOLUME OF DAM = 387,141 CU. YDS.
2. CONTOURS DEPICT ASSUMED TOP OF ROCK.
AXIS OF DAM
TOE OF DAM
PLAN
SCALE: A
CANTILEVER NUMBERS
26 25 24 23 22 21 20 19 18 17 16 15 14
534.00
531.00
500.00
462.00
426.00
375.00
325.00
316.00
LIMIT OF EXCAVATION
ASSUMED TOP OF ROCK
UPSTREAM ELEVATION
DEVELOPED LOOKING UPSTREAM
SCALE: A
EL.534.0
EL.531.0
EL.500.0
EL.462.5
EL.420.0
EL.375.0
EL.325.0
EL.316.0
0.35
1
110.60
REFERENCE PLANE
SCALE: B
GRAPHIC SCALES
200' 0 200'
"A"
100' 0 100'
"B"

Project Approach

- Phase I - Preliminary Analysis
  - Model testing (concurrent with dam design)
  - Parametric study to determine significant parameters
- Phase II – Final Analysis
  - Final dam geometry
  - Final material properties

Analysis Procedure





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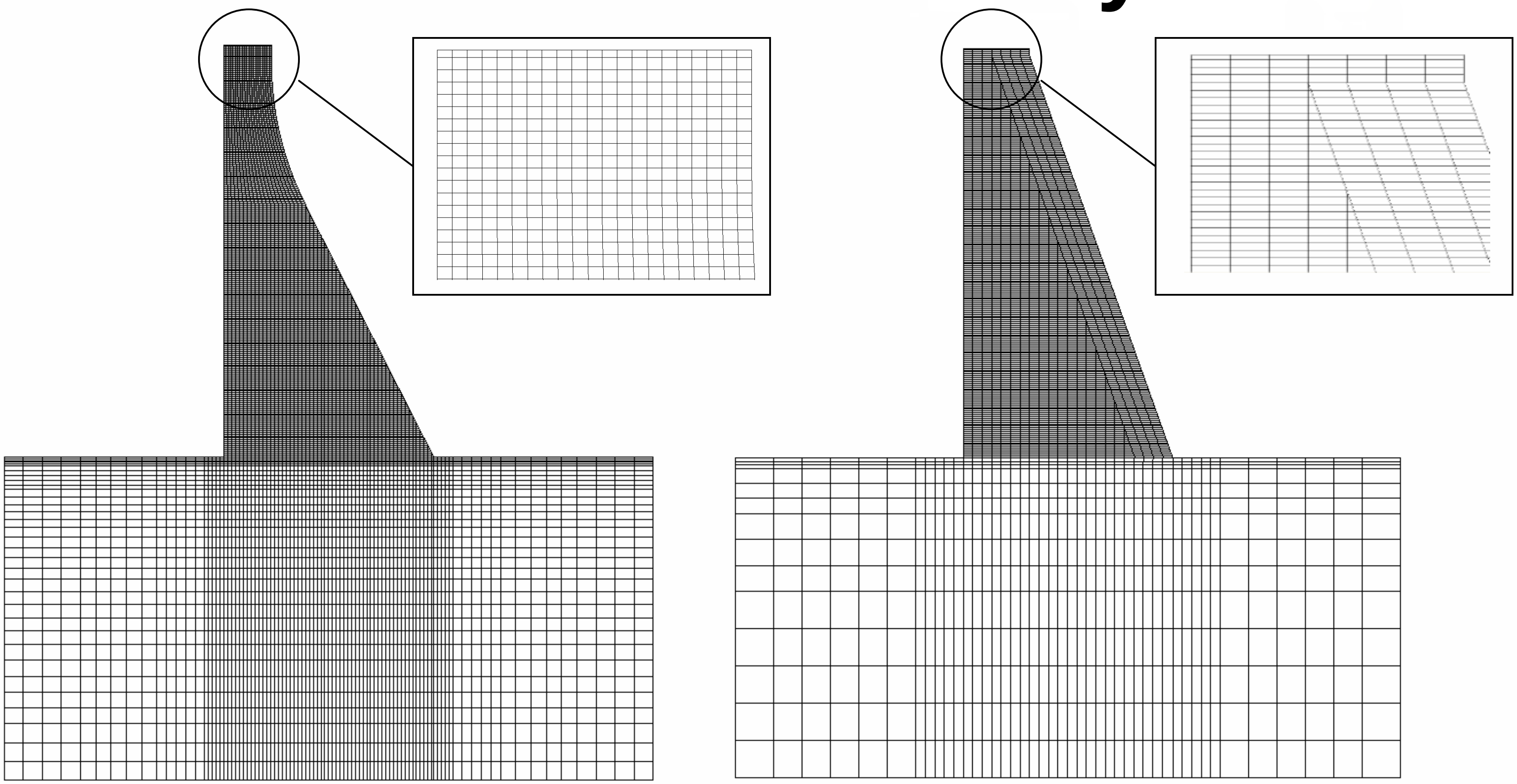
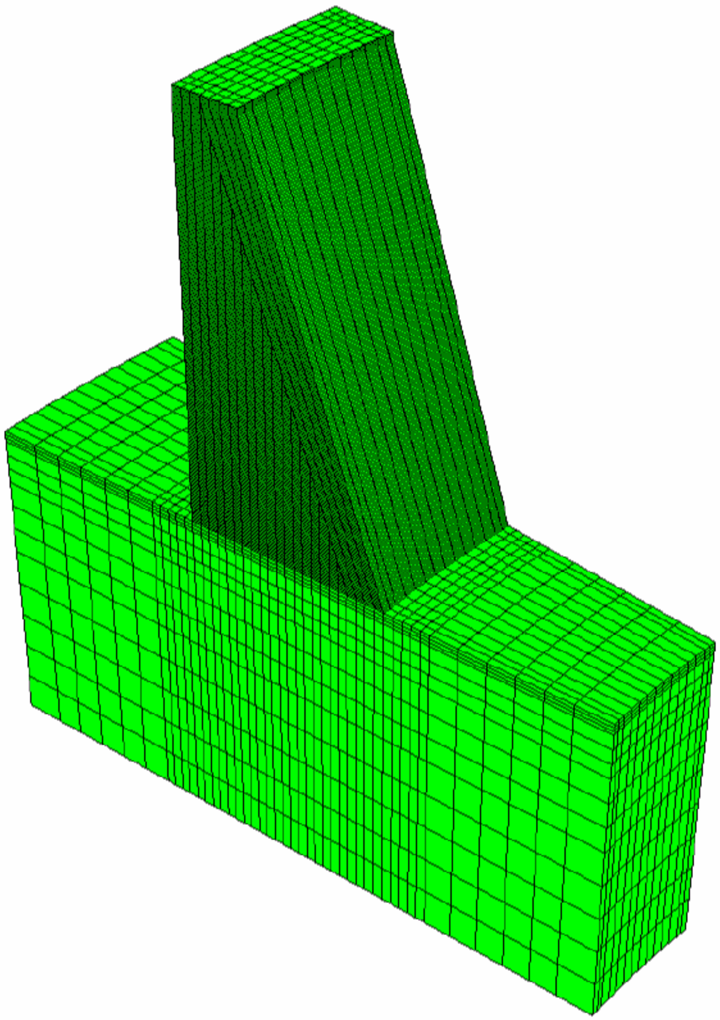
Analysis Approach
(ETL 1110-2-365)

- De-coupled thermal/stress analysis using ABAQUS/Standard
- Combination 2D and 3D analysis
- Incremental placement of lifts
- Material nonlinearity
- Boundary conditions

2D Dam Geometry

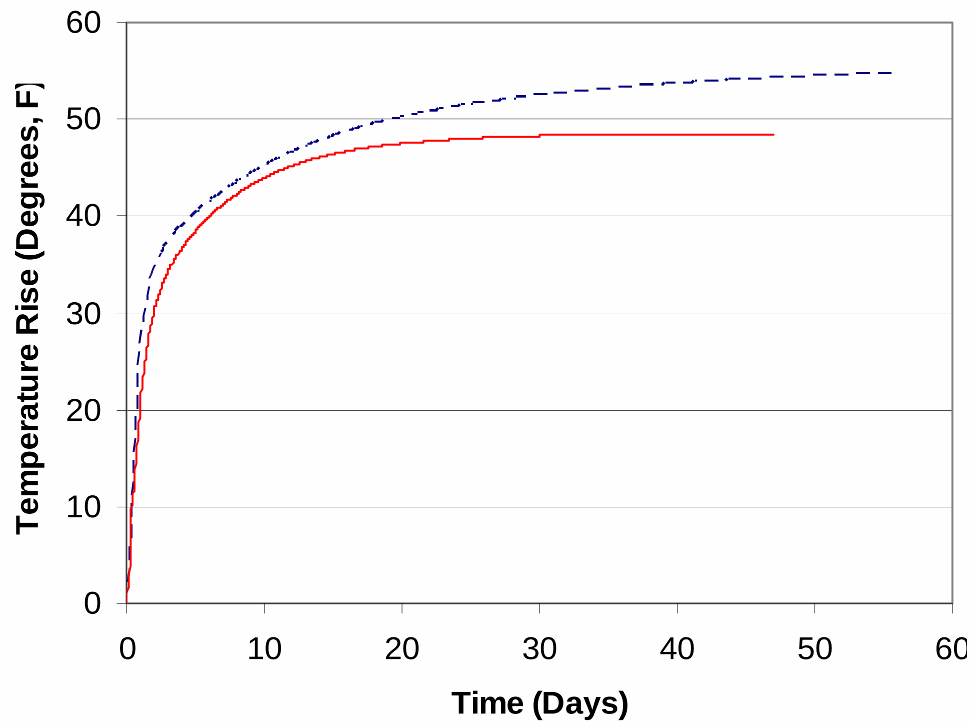


3D Dam Geometry



Thermal Material Properties

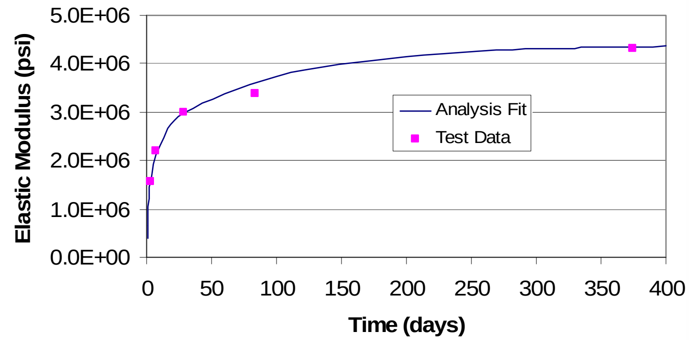
- Roller compacted concrete
  - Non linear internal heat generation (heat of hydration from adiabatic temperature rise)
  - All other properties linear (Cp, k, γ)
- Linear (uniform) foundation material

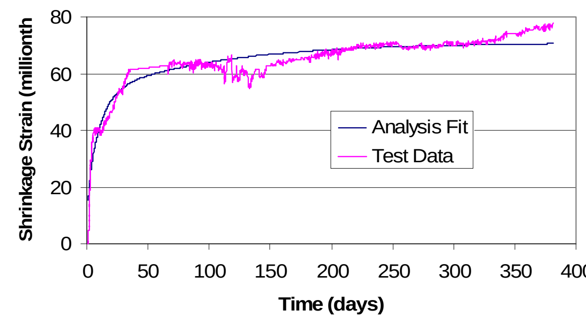


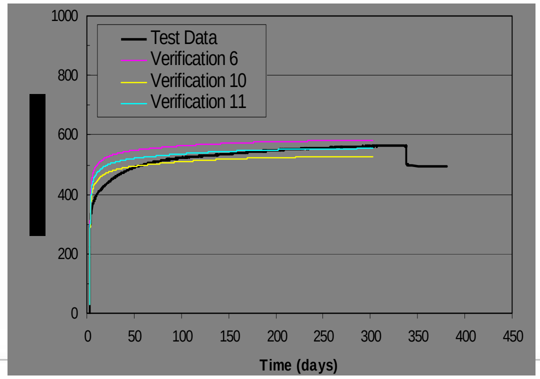
$$\dot{H} = \gamma \cdot C_p \cdot \frac{\Delta\theta}{\Delta t} \qquad (\text{BTU/in}^3\text{/day})$$

Structural Material Properties

- General nonlinear properties for RCC
  - Modulus
  - Shrinkage
  - Creep/Aging
- Linear foundation material







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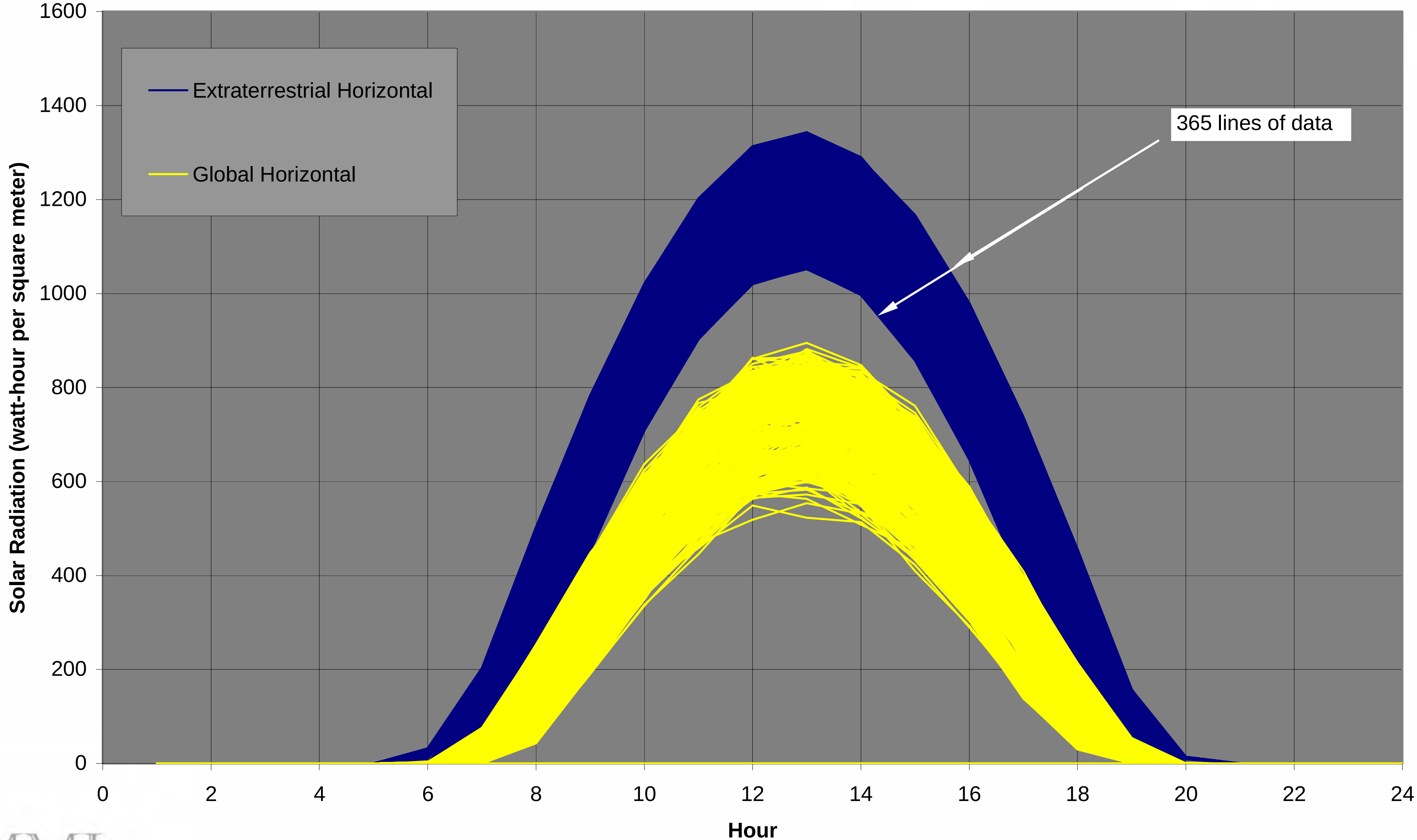
Boundary Conditions

- Thermal analysis
  - Time/temperature dependent transfer films
  - Solar radiation flux
  - Heat loss to foundation
- Structural analysis
  - Foundation constraint
  - 3D Model - contact at construction joints

Average Solar Radiation (1961-1990)
(every hour for 365 days)



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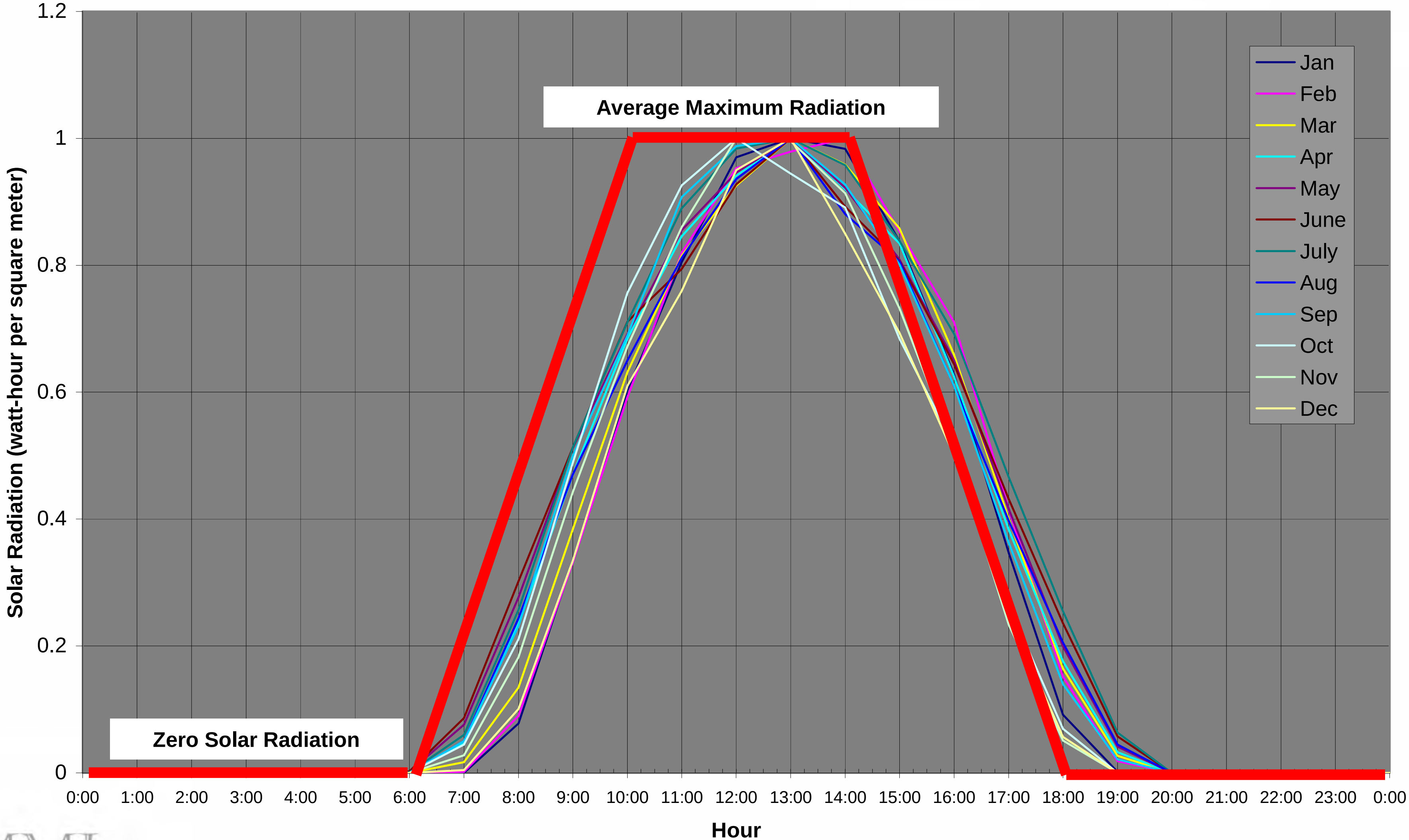
Average Data (1961 - 1990) 15th Day of Each Month
Global Horizontal (Normalized to Max)



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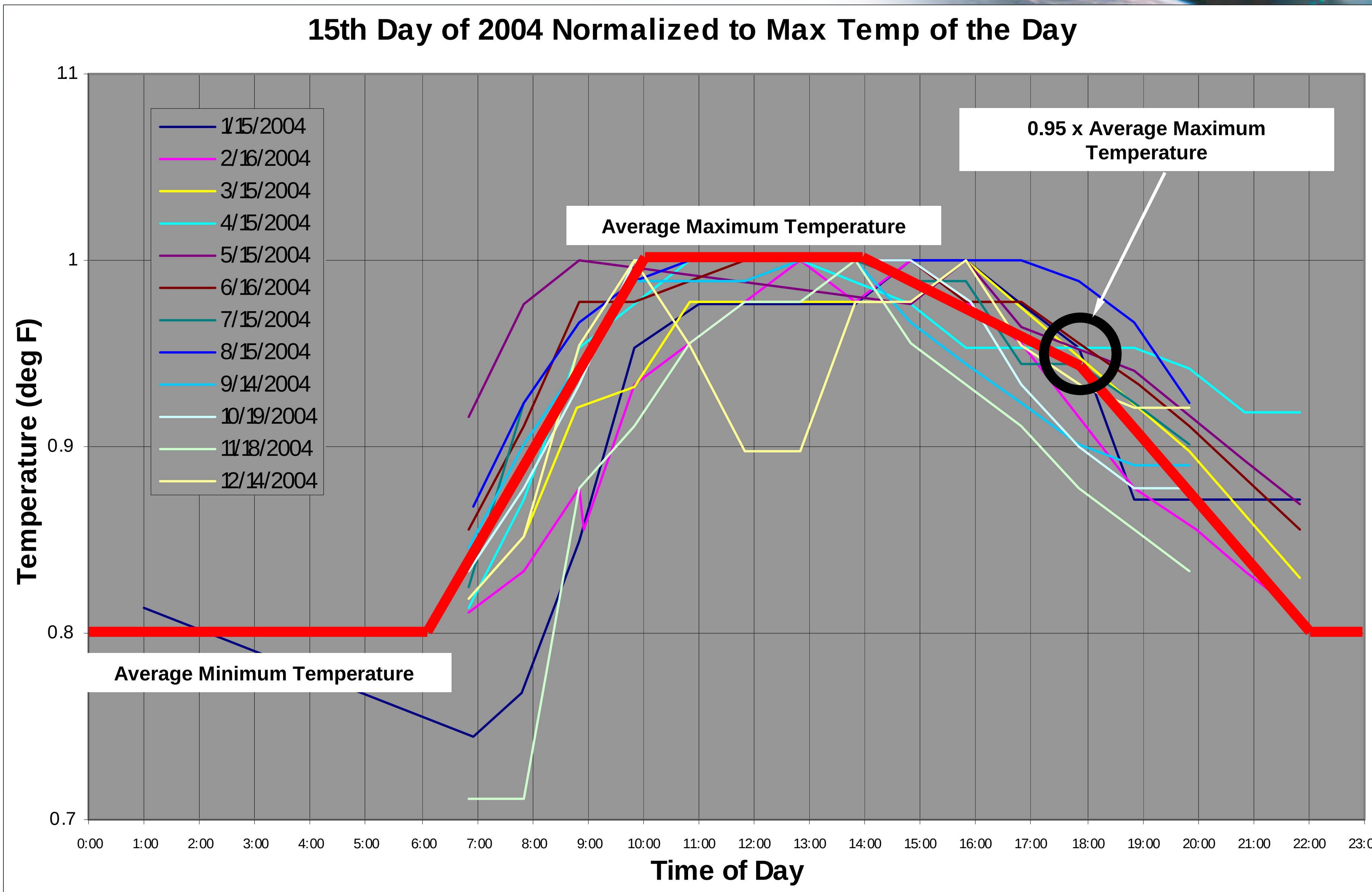

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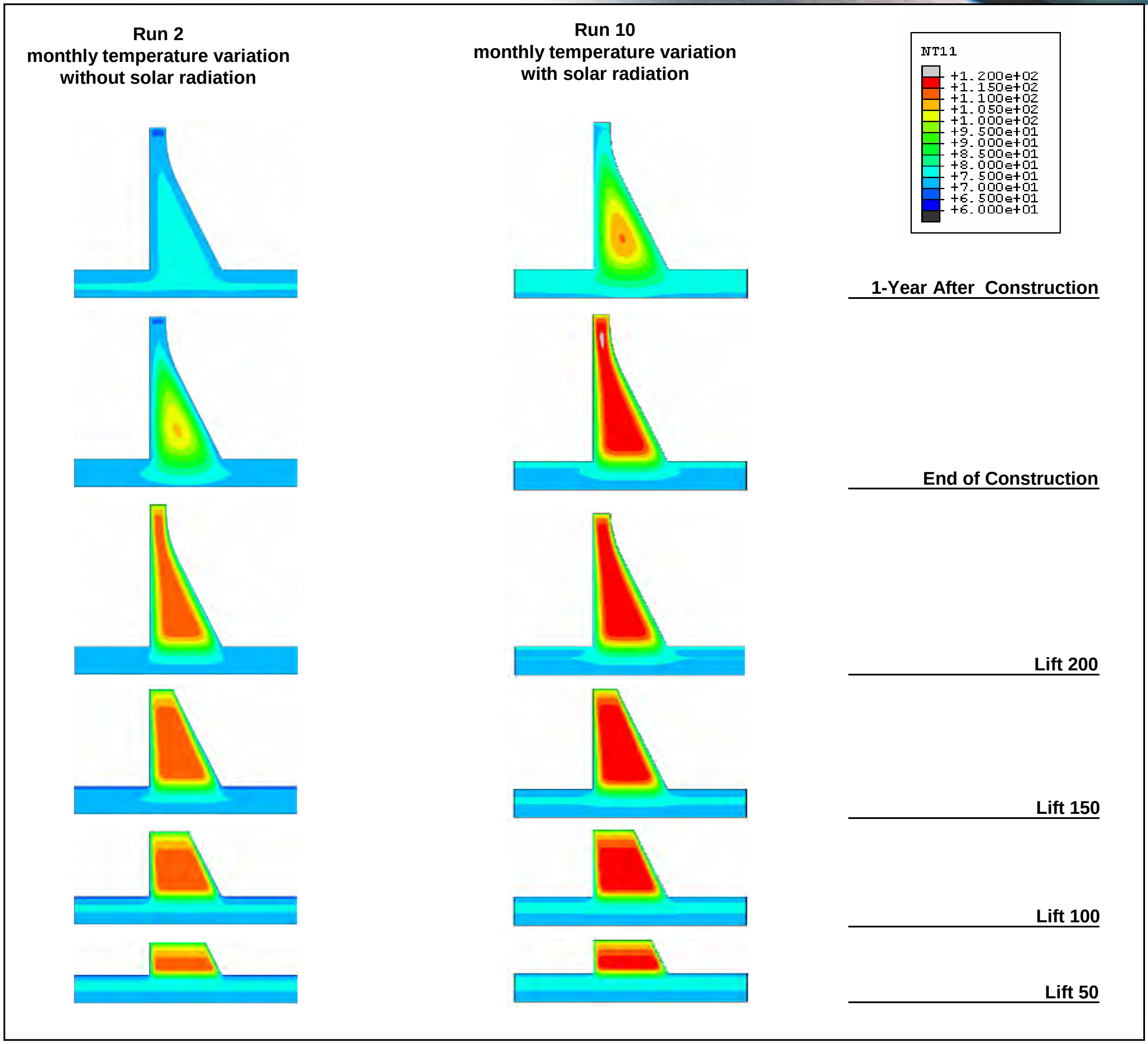
Phase I Example Results



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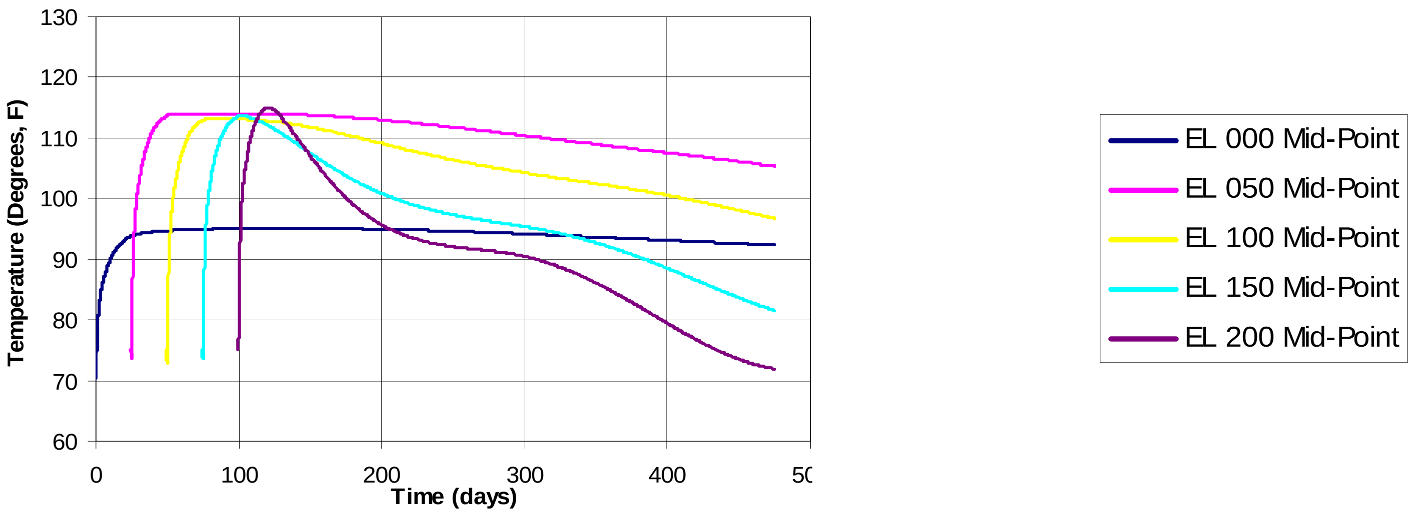
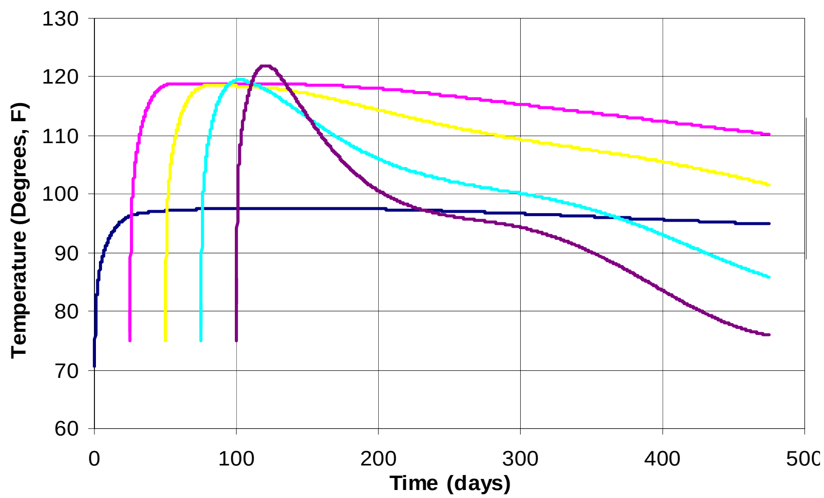
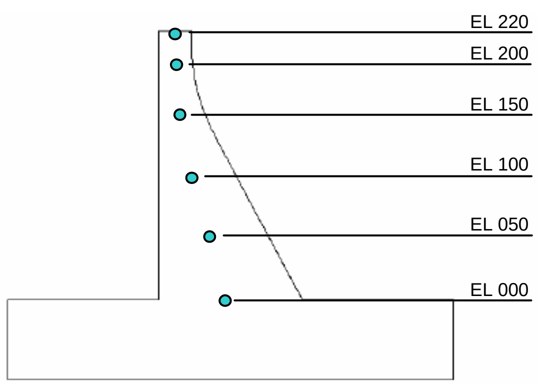
Phase I Example Results



(a) Solar Radiation not Included (Run 2)



(b) Solar Radiation Included (Run 10)



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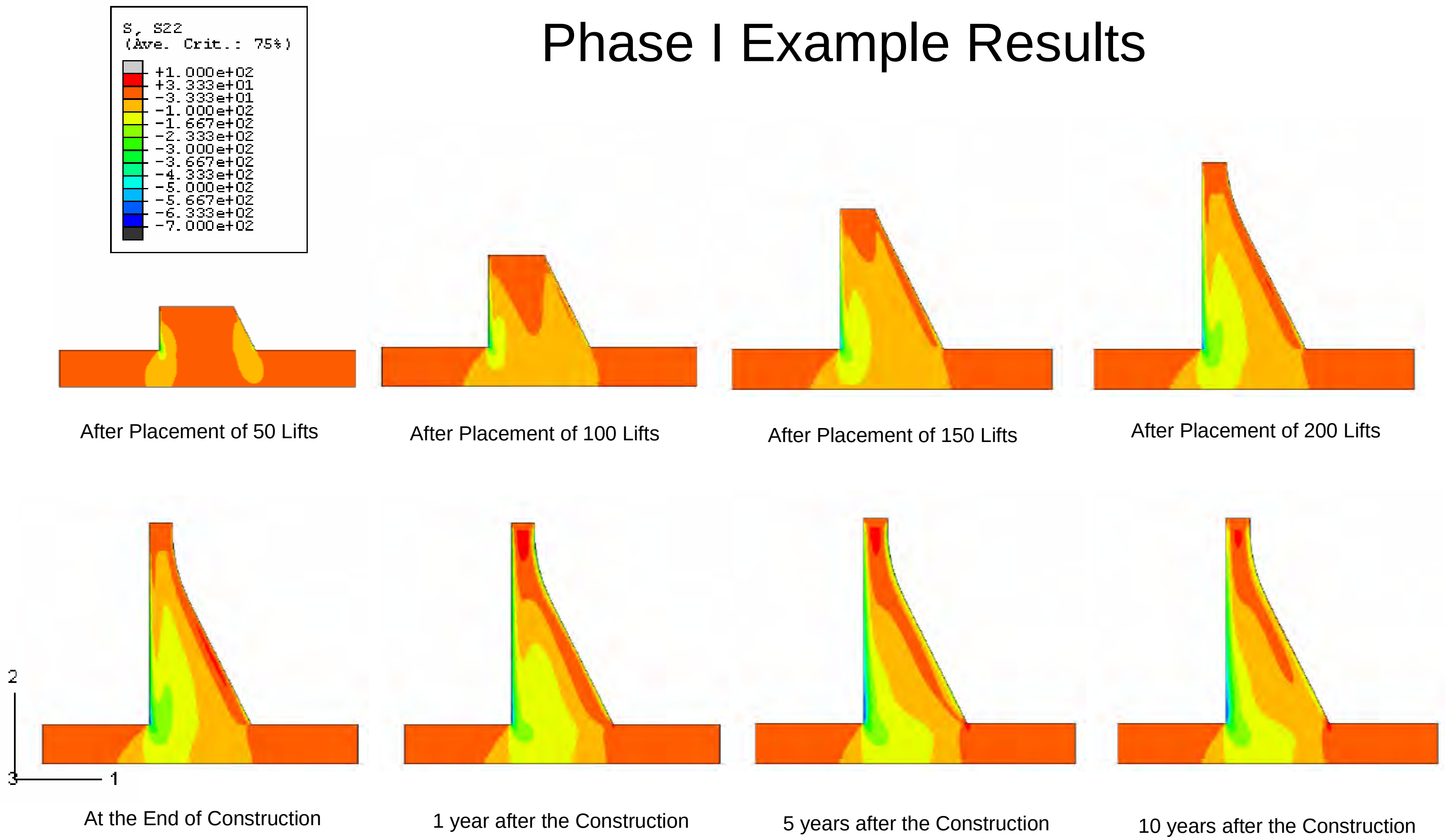
Phase I Example Results



Simplified Analysis

- Tatro & Schrader
- ACI 207.2R-95
- ETL 1110-2-542

Simplified Thermal Analysis of Portugues Dam

Structural Properties

Crest length X	1,298.1 ft	15,577 in
Cross section length L	110 ft	
Cross section height H	220 ft	
L/H	0.5	
A_f/A_g	2.5	

Monthly Average Temperatures

January	75.0 °F
February	75.2 °F
March	75.7 °F
April	77.1 °F
May	78.9 °F
June	80.4 °F
July	80.9 °F
August	80.8 °F
September	80.2 °F
October	79.5 °F
November	77.9 °F
December	75.8 °F
Average	78.1 °F

RCC Thermal Properties

Adiabatic temperature rise T_{ad}	48 °F (25+ days)	
Specific heat C_h	0.234 BTU/lb-°F	
Conductivity K	1.835334 BTU/in-day-°F	
Diffusity h^2	3.5 in^2/hr	0.024 ft^2/hr

Thermal Data

RCC placement temperature T_i	78.1 °F
Final stable temperature T_f	78.1 °F

(Assume the internal mass will cool to the average annual temperature)

Induced strain

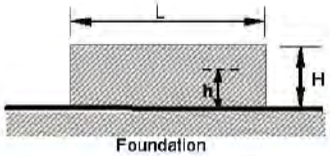
Long term temperature change $dT=T_i+T_{ad}-T_f$	48.0 °F
Induced strain $\varepsilon = C_T dT K_R K_f$	2.02E-04
Cracking strain $\varepsilon_{cr} = \varepsilon - \varepsilon_{sc}$	9.50E-05
Total crack width (shrinkage) $cw_{total} = \varepsilon_{cr} L$	1.48 in
Assumed crack width (cw)	0.125 in
No of cracks $N = cw_{total}/cw$	11.84
Average crack spacing $S = X/N$	109.6 ft

RCC Mechanical Properties

Coefficient of thermal expansion C_T	4.2E-06 /°F
Weight density w_c	0.09265046 lb/in^3
Tensile strain capacity ε_{sc}	1.065E-04
Modulus of elasticity RCC E_c	4.30E+06
Modulus of elasticity foundation E_f	3.70E+06

Restraint Factors

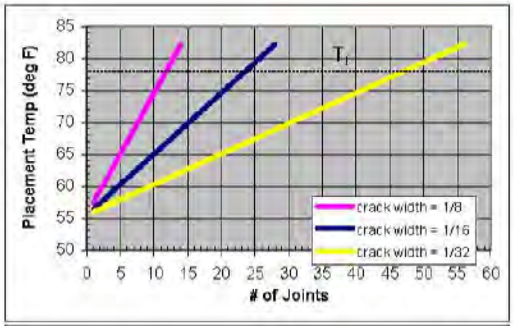
Compute restraint factors (Y or N)?	n
h/H	0
Structural restraint factor K_R	1.00
Foundation restraint factor K_f	1.00

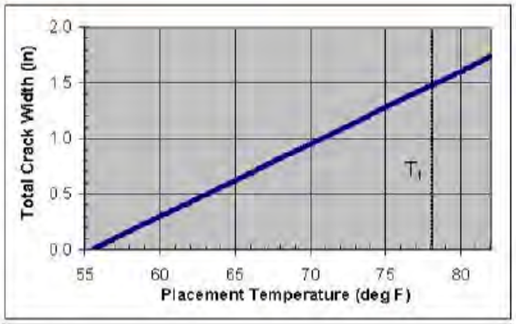


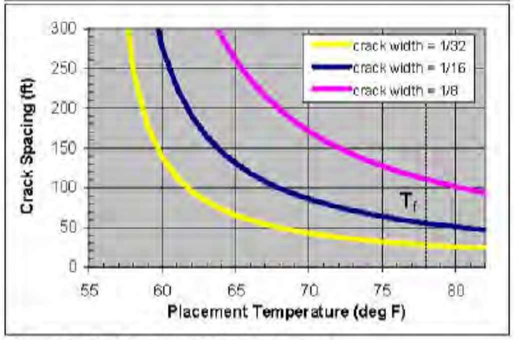
$$K_R = \left(\frac{\frac{L}{H} - 2}{\frac{L}{H} + 1} \right)^{h/H} \quad for L / H \geq 2.5$$

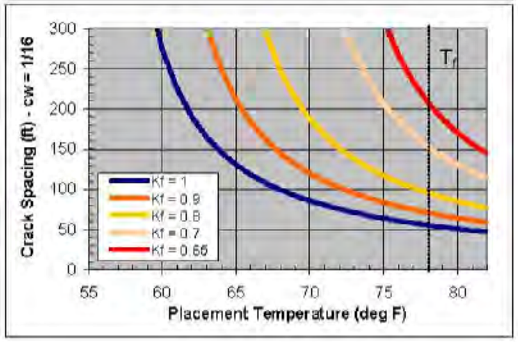
$$K_R = \left(\frac{\frac{L}{H} - 1}{\frac{L}{H} + 10} \right)^{h/H} \quad for L / H < 2.5$$

$$K_f = \frac{1}{1 + \frac{A_g E_c}{A_f E_f}}$$



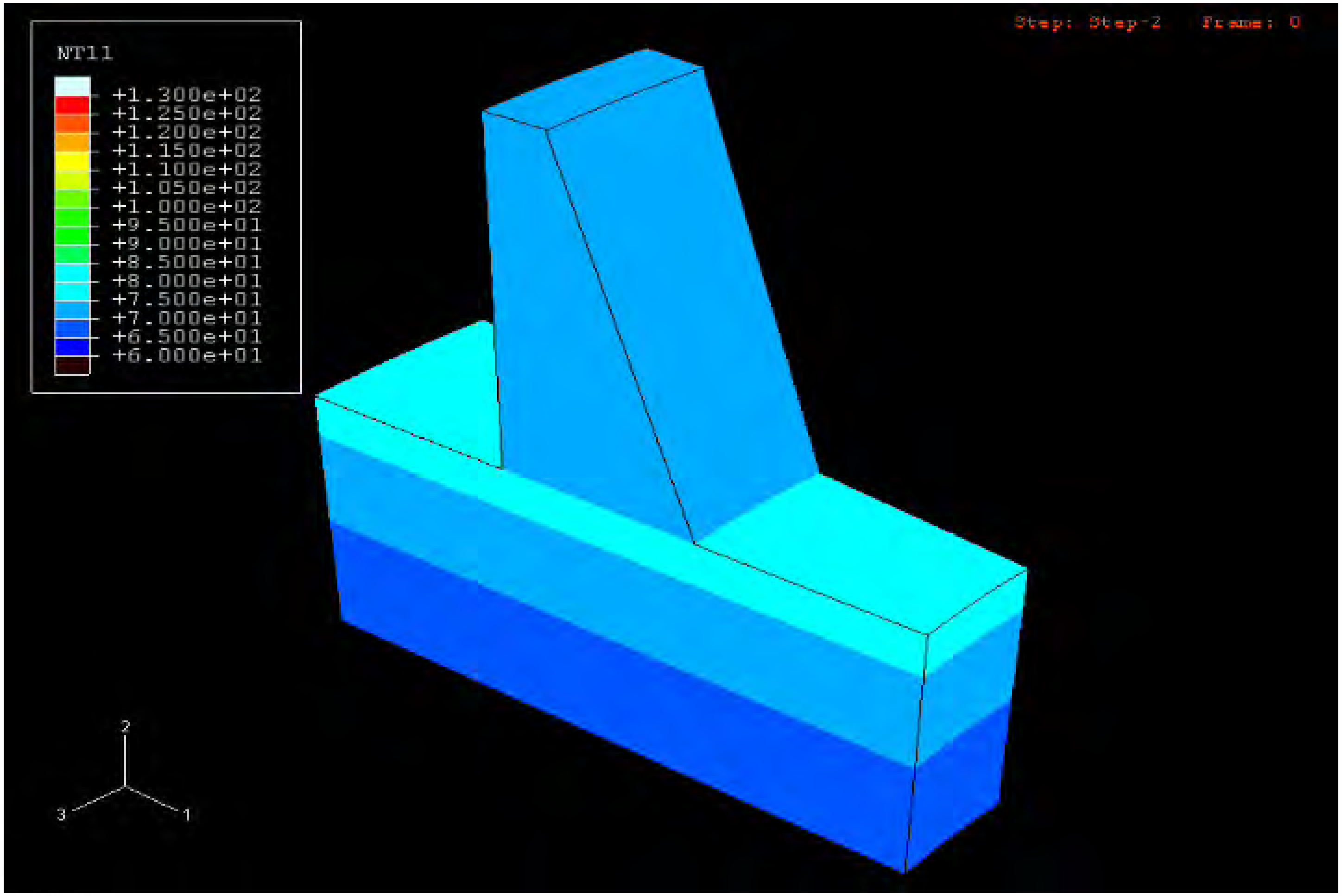




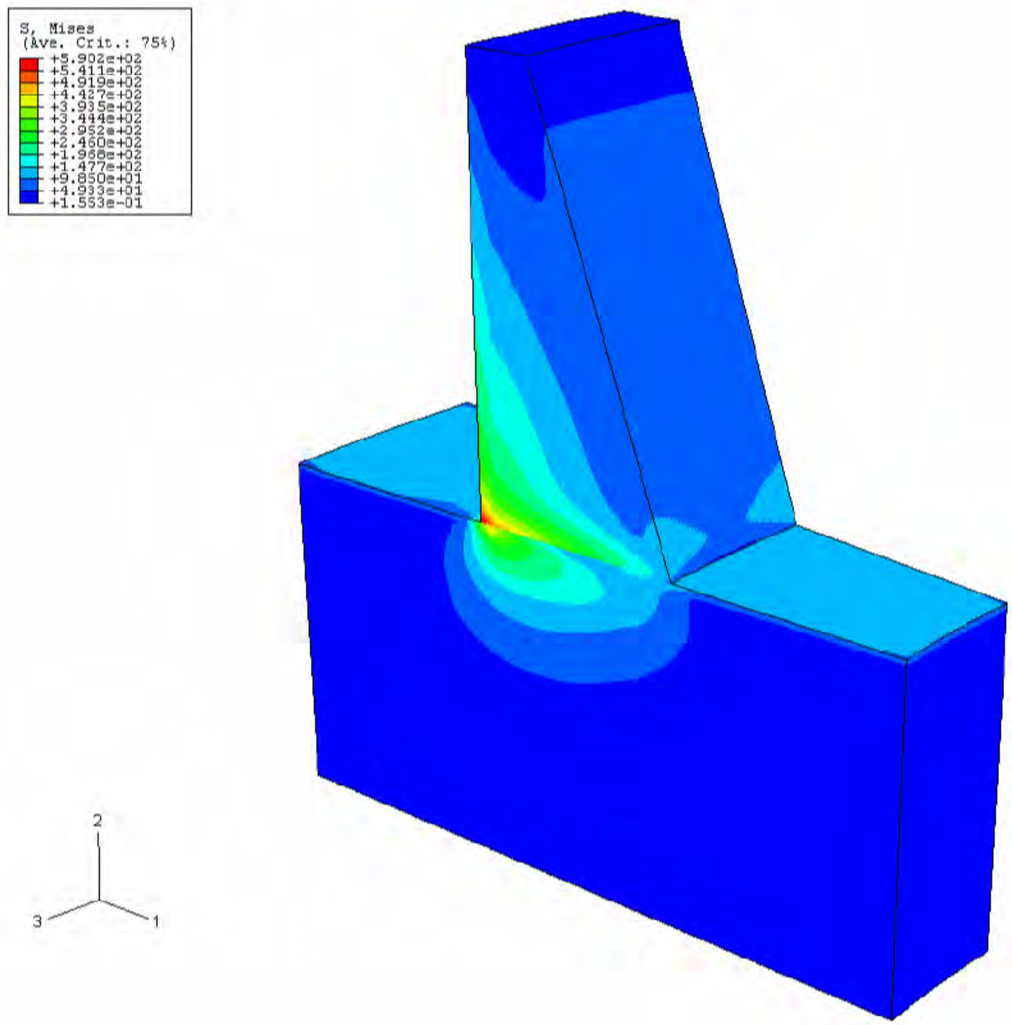


Note: Kf = Kr = 1, if not specified on the graph

Results Status (Phase II) - Thermal



Results Status Phase II - Stress



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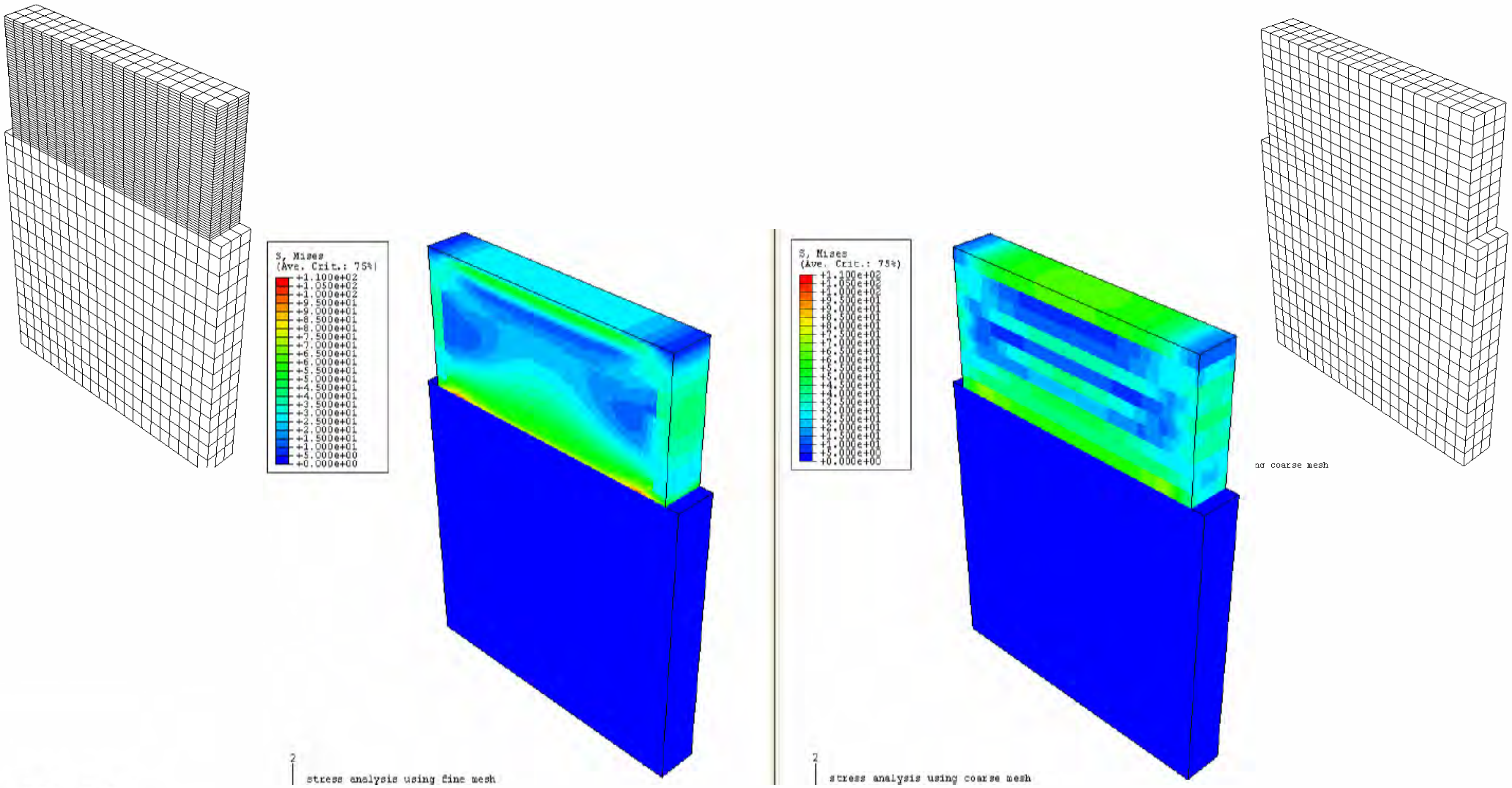
Remaining Steps

- Thermal component of analysis are nearing completion
- Stress analysis
  - Construction sequence completed
  - Long term cool down requires coarser mesh to achieve adequate computational performance
- Coarse mesh mapping of thermal results is underway – reasonable comparison is being obtained

Mesh Mapping Methods



Analytical Management

- Management of model size
  - Geometry (lift size)
  - Load time step resolution (solar radiation/daily temperature variation)
  - Long duration for dam cool down (years rather than months)
- 3rd party material model usage
  - It would be more convenient to use an internal material model in ABAQUS

MMI ENGINEERING
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Analytical Management

- Software bugs
  - Debugging vendor software
  - Memory management issues (porting of software to non native platforms)
- Software limitations (and workarounds)
  - Mesh mapping to reduce computational overheads of stress analysis phase of work
  - Selection of contact algorithms

USACE Homeland Security Portal

Michael Pace

ERDC, ITL

Vicksburg, MS

2005 Tri-Service Infrastructure Conference

St. Louis, MO

August 2005

ERDC Engineer Research and Development Center

CISP R&D Program Formulation

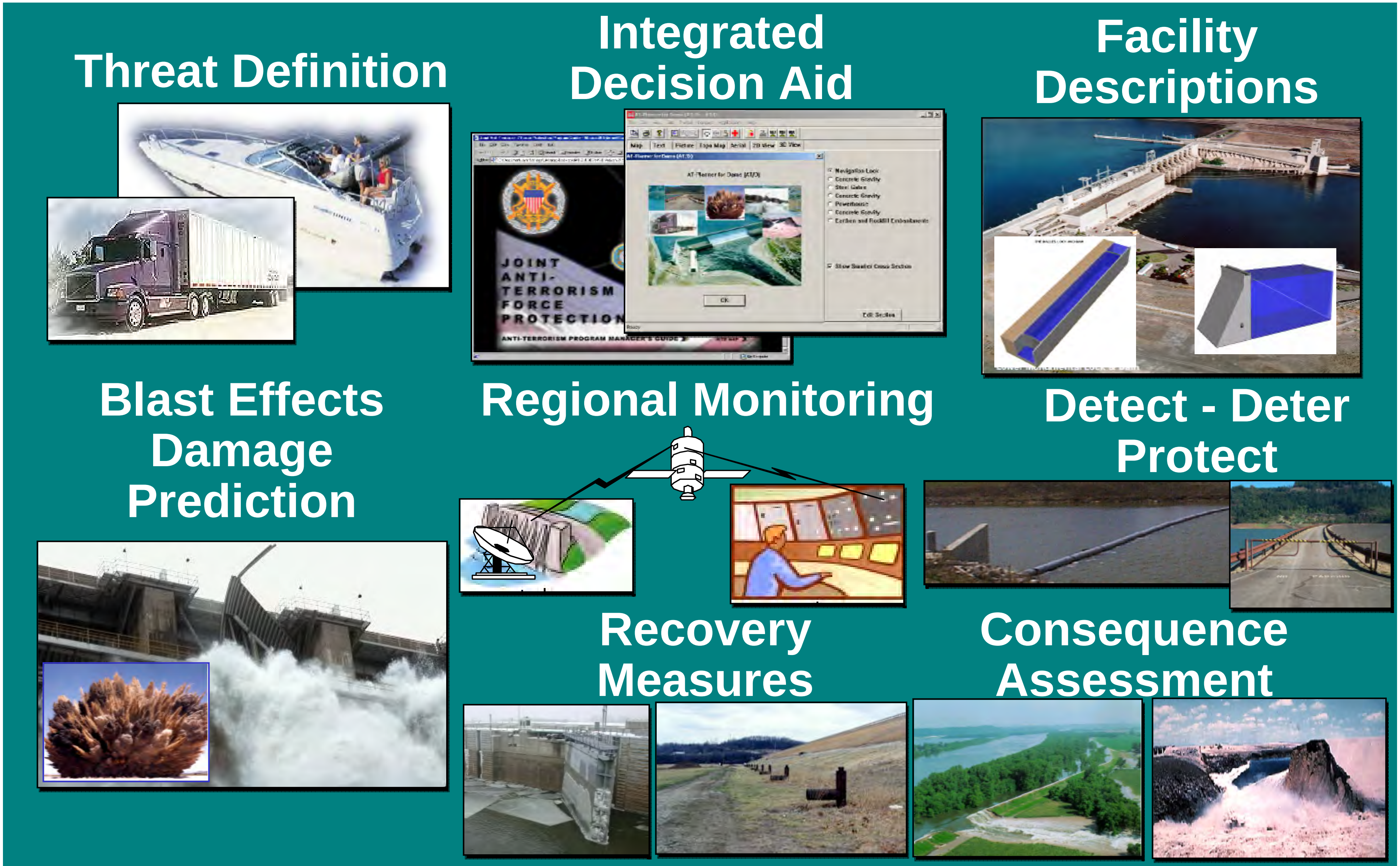
CISP R&D PROGRAM

VULNERABILITY & CONSEQUENCE ASSESSMENT	DETECT, DETER, & PROTECT	RAPID RESPONSE, RECOVERY, & REPAIR	TECHNOLOGY TRANSFER

CORPS SECURITY AND PROTECTION R&D NEEDS

ERDC
Engineer Research and Development Center

CISP Research Areas

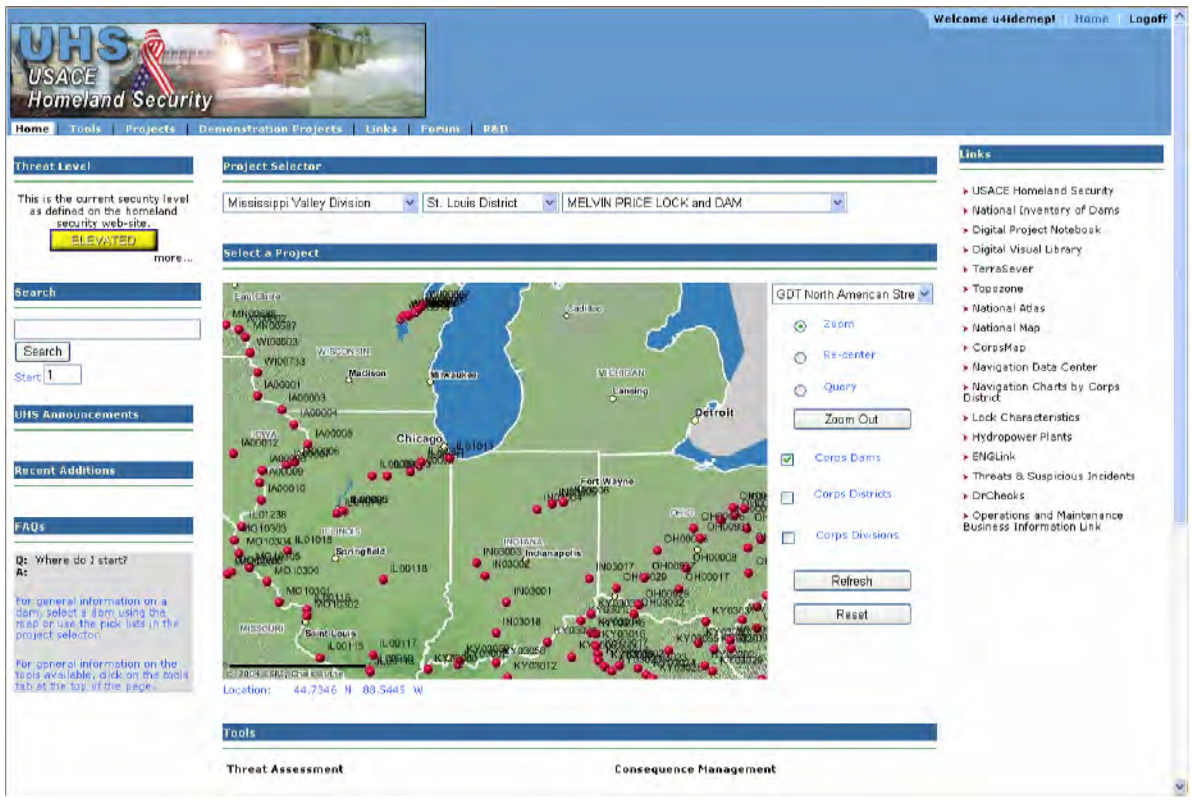


Web Portal?

- Definition from Webopedia:
  - "*Commonly referred to as simply a portal, a Web site or service that offers a broad array of resources and services, such as e-mail, forums, search engines, and on-line shopping malls. The first Web portals were online services, such as AOL, that provided access to the Web, but by now most of the traditional search engines have transformed themselves into Web portals to attract and keep a larger audience*."

Objective

- Develop framework for efficiently managing data, documents, and tools with easy, controlled access to support Homeland Security needs



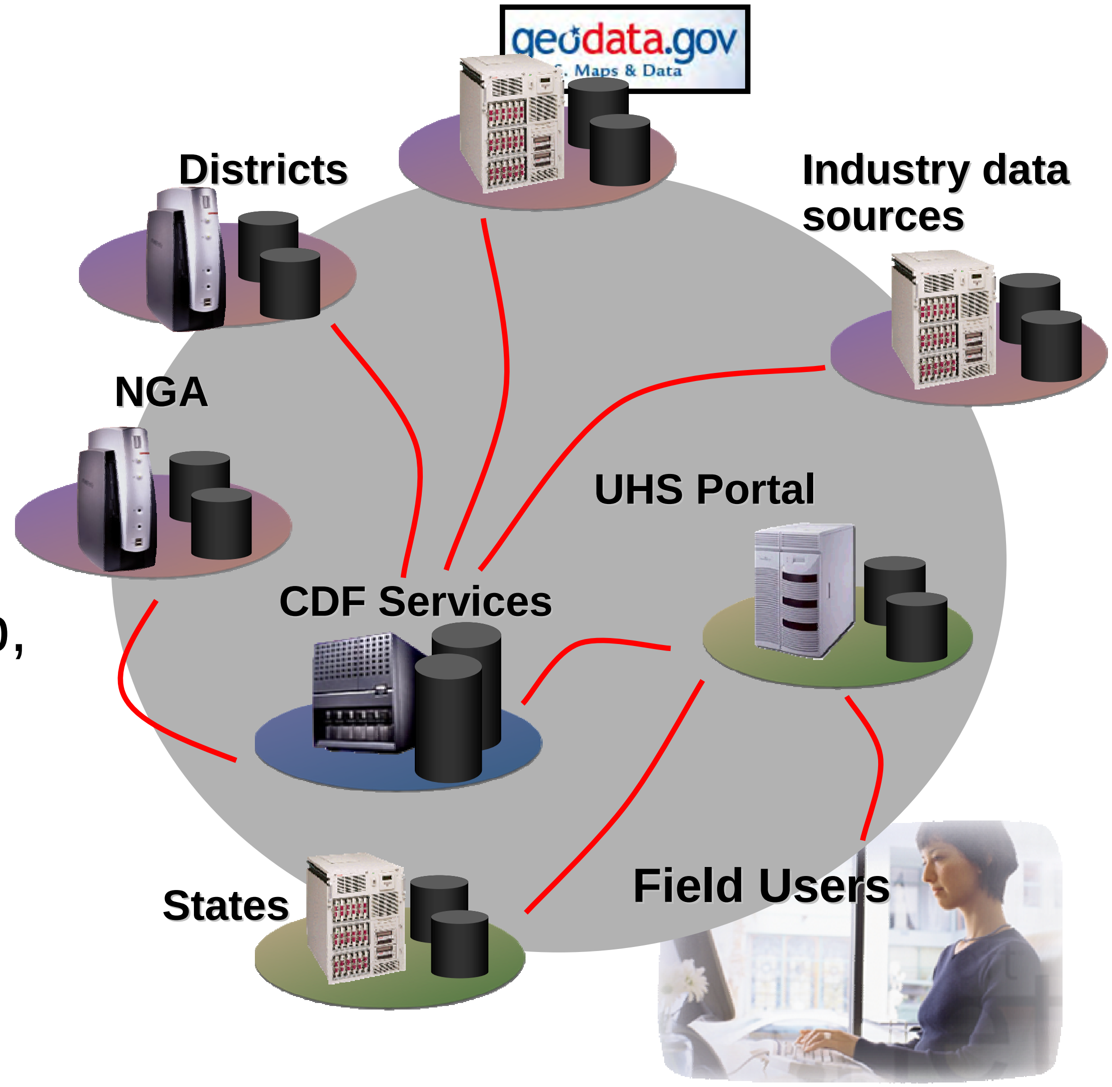
ERDC Engineer Research and Development Center

Portal Capabilities

- Serves as the download site for R&D and security-related tools or models and the data required to perform assessments
- Provides repository of information pertaining to projects
  - Content management
  - HQ, Division, District level can add or delete data
- Provides central place to archive and search for data, data sources, documents, tools
  - Search web portal plus USACE and business partners
  - Retrieves data of interest from varied sources
- Lite GIS capability for viewing/analysis of assets

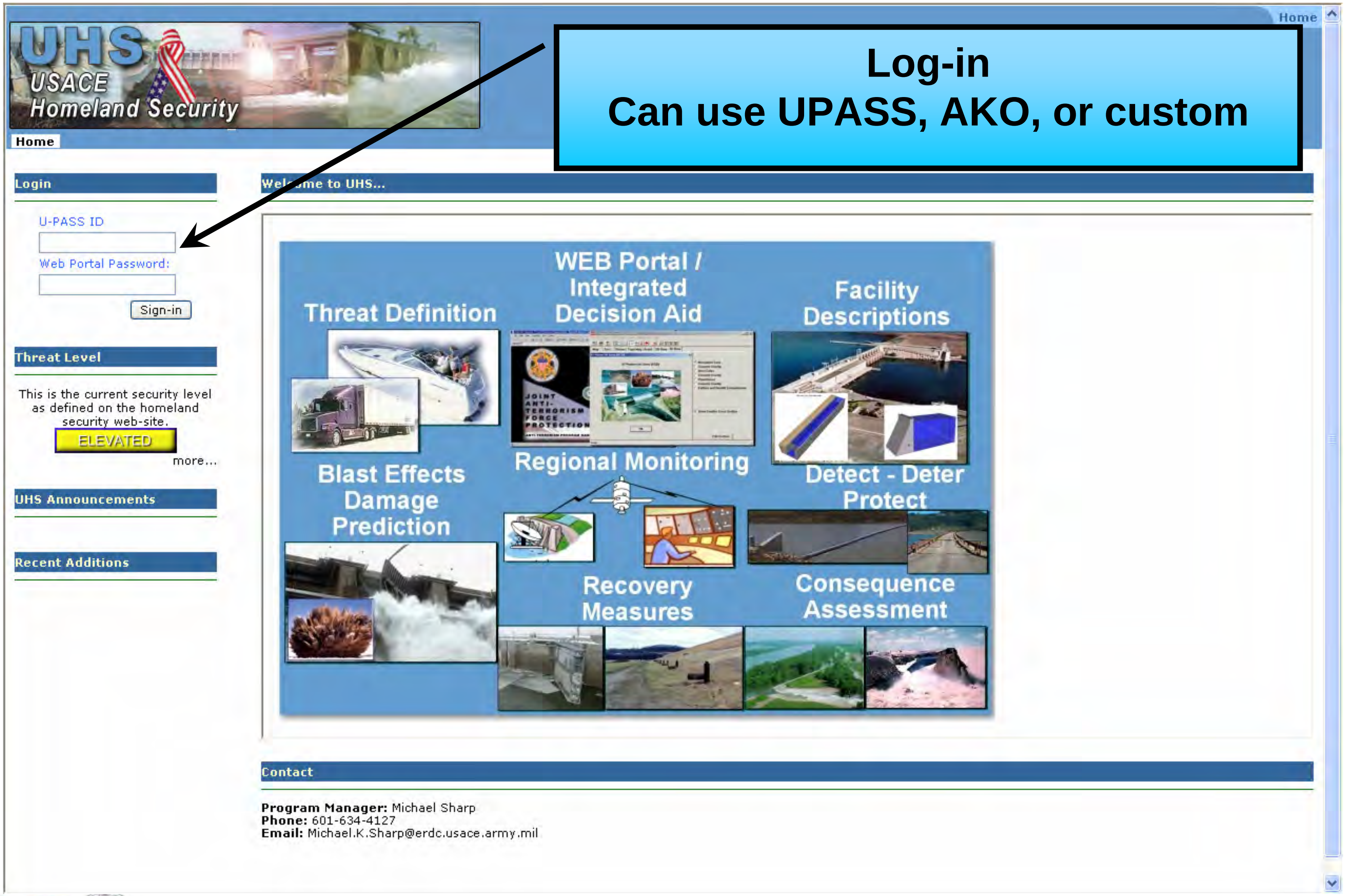
Data

- Driven by tool requirements
- Data sources
  - USACE (DPN, ENGLink)
  - Federal (USGS, NGA, DHS, Geospatial One-stop, etc.)
  - State agencies
  - Industry (ESRI, etc.)
- Published links and automated data retrieval



Controlled Access

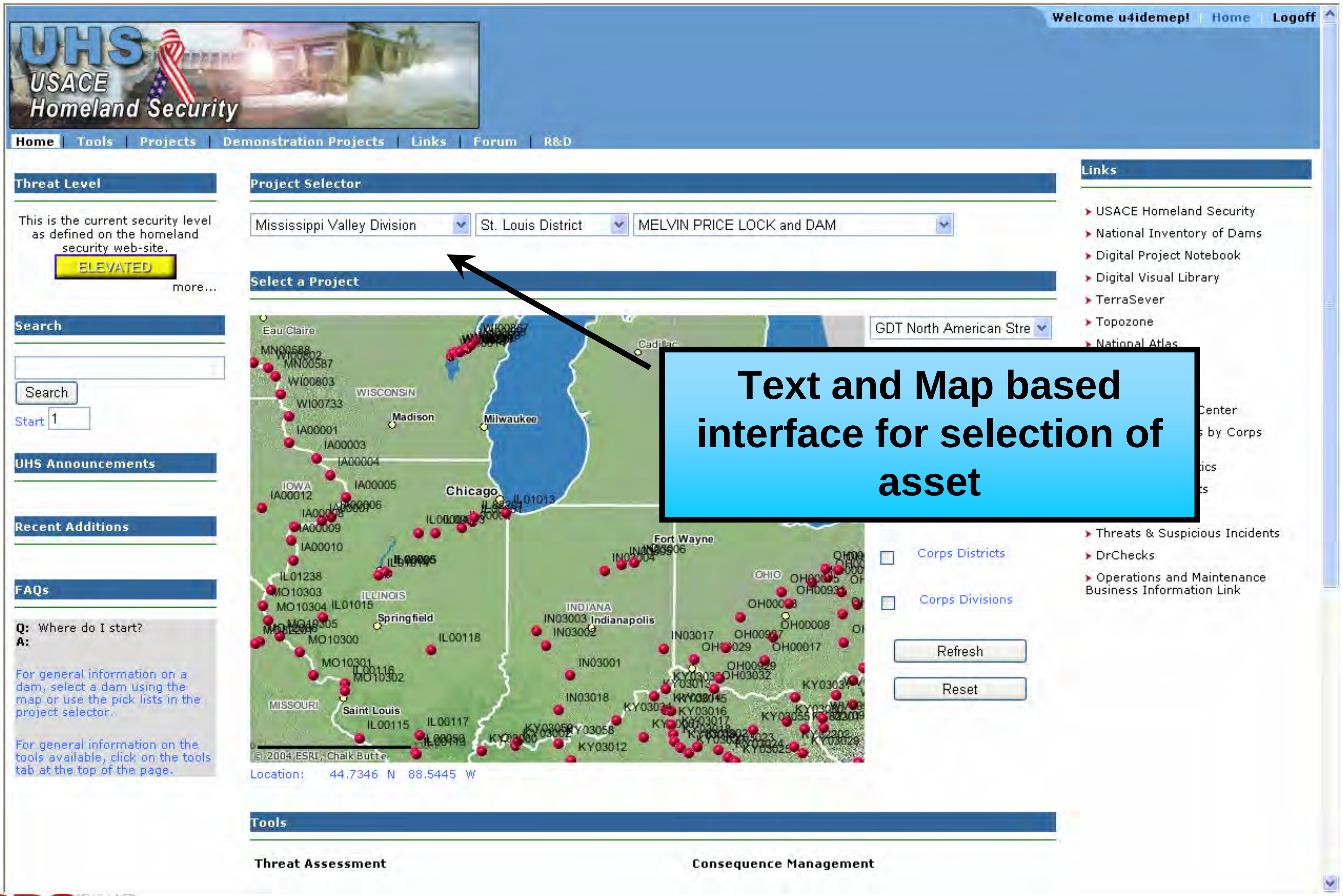
Log-in
Can use UPASS, AKO, or custom



Main Page

ERDC Engineer Research and Development Center

Main Page



Text and Map based interface for selection of asset

Main Page

UHS Announcements

Recent Additions

FAQs

Q: Where do I start?
A:

For general information on a dam, select a dam using the map or use the pick lists in the project selector.

For general information on the tools available, click on the tools tab at the top of the page.

Location: 44.7346 N 88.5445 W

Zoom Out

- [x] Corps Dams
- [ ] Corps Districts
- [ ] Corps Divisions

- Lock Characteristics
- Hydropower Plants
- ENGLink
- Threats & Suspicious Incidents
- DrChecks
- Operations and Maintenance Business Information Link

Quick access to tools

Tools

Threat Assessment

- TSI Database
- SEPA Process - PDC

Consequence Assessment

- Assessment of Relief Well Damage to Embankments
- 2D Dam Break – Adaptive Hydraulics Model
- Scour and Erosion

Protection Methods / Design Guides

- Waterside protection
- Waterborne attack detection
- Mitigation of Truck Bomb Craters on Embankment Dams
- Regional Monitoring

Consequence Management

- Rapid Recovery for Lock and Dam Gates

Vulnerability Assessment

- AT Planner for Dams
- AT Planner for Buildings
- BEEM
- CONWEP
- Bridge Tools

Risk Assessment

- RAM-D (spreadsheet version)
- DAMSVR

JAT/FP Tools

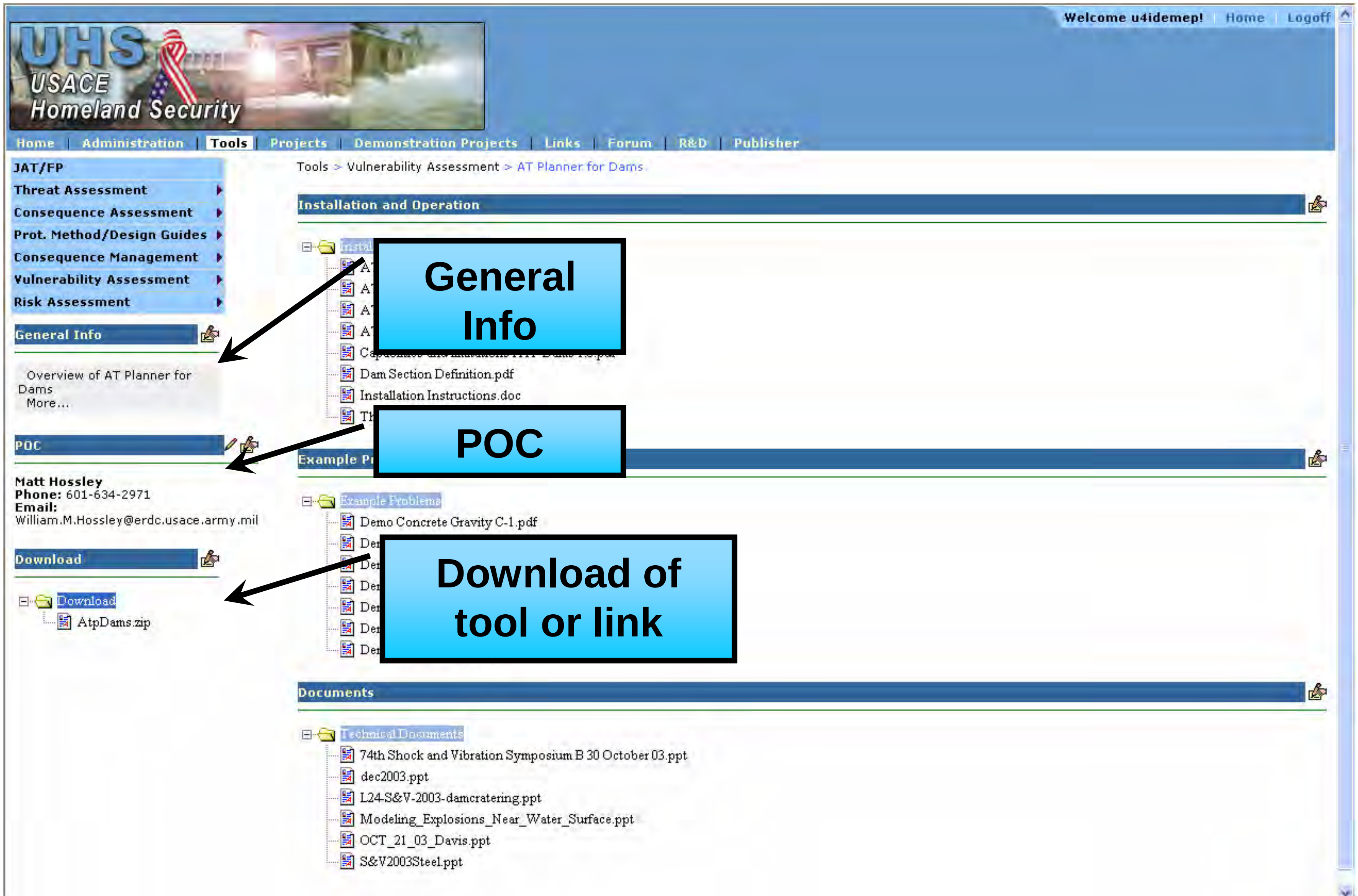
Contact

Program Manager: Michael Sharp
Phone: 601-634-4127
Email: Michael.K.Sharp@erdc.usace.army.mil

Tools

ERDC Engineer Research and Development Center

Tools



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JAT/FP
Threat Assessment
Consequence Assessment
Prot. Method/Design Guides
Consequence Management
Vulnerability Assessment
Risk Assessment
General Info
Overview of AT Planner for Dams
More...
POC
Matt Hossley
Phone: 601-634-2971
Email:
William.M.Hossley@erdc.usace.army.mil
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Dam Section Definition.pdf
Installation Instructions.doc
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Demo Concrete Gravity C-1.pdf
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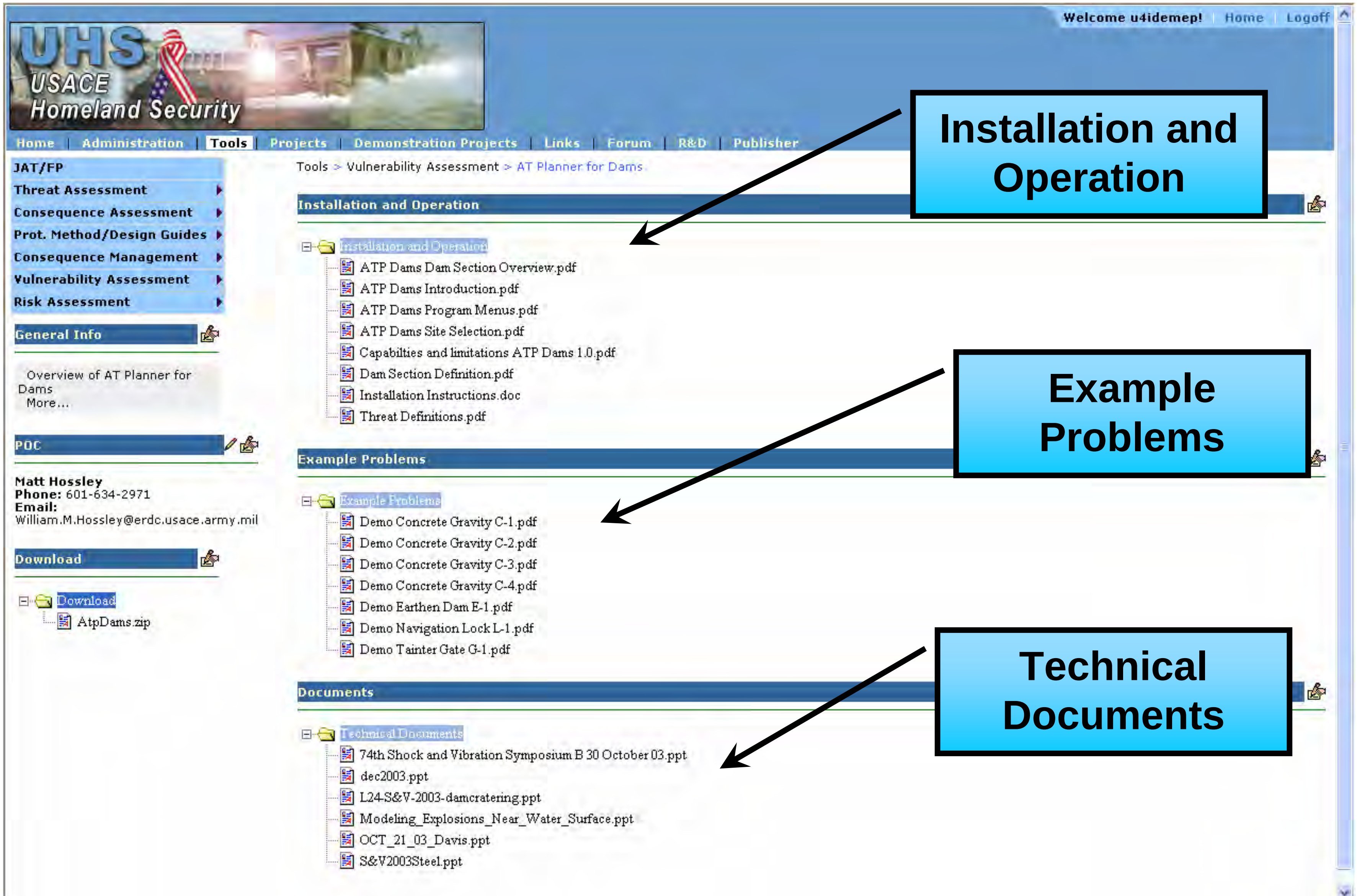
Technical Documents
74th Shock and Vibration Symposium B 30 October 03.ppt
dec2003.ppt
L24-S&V-2003-damcratering.ppt
Modeling_Explosions_Near_Water_Surface.ppt
OCT_21_03_Davis.ppt
S&V2003Steel.ppt
General Info
POC
Download of tool or link

Tools



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Capabilties and limitations ATP Dams 1.0.pdf
Dam Section Definition.pdf
Installation Instructions.doc
Threat Definitions.pdf
Example Problems
Example Problems
Demo Concrete Gravity C-1.pdf
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Demo Concrete Gravity C-3.pdf
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Demo Navigation Lock L-1.pdf
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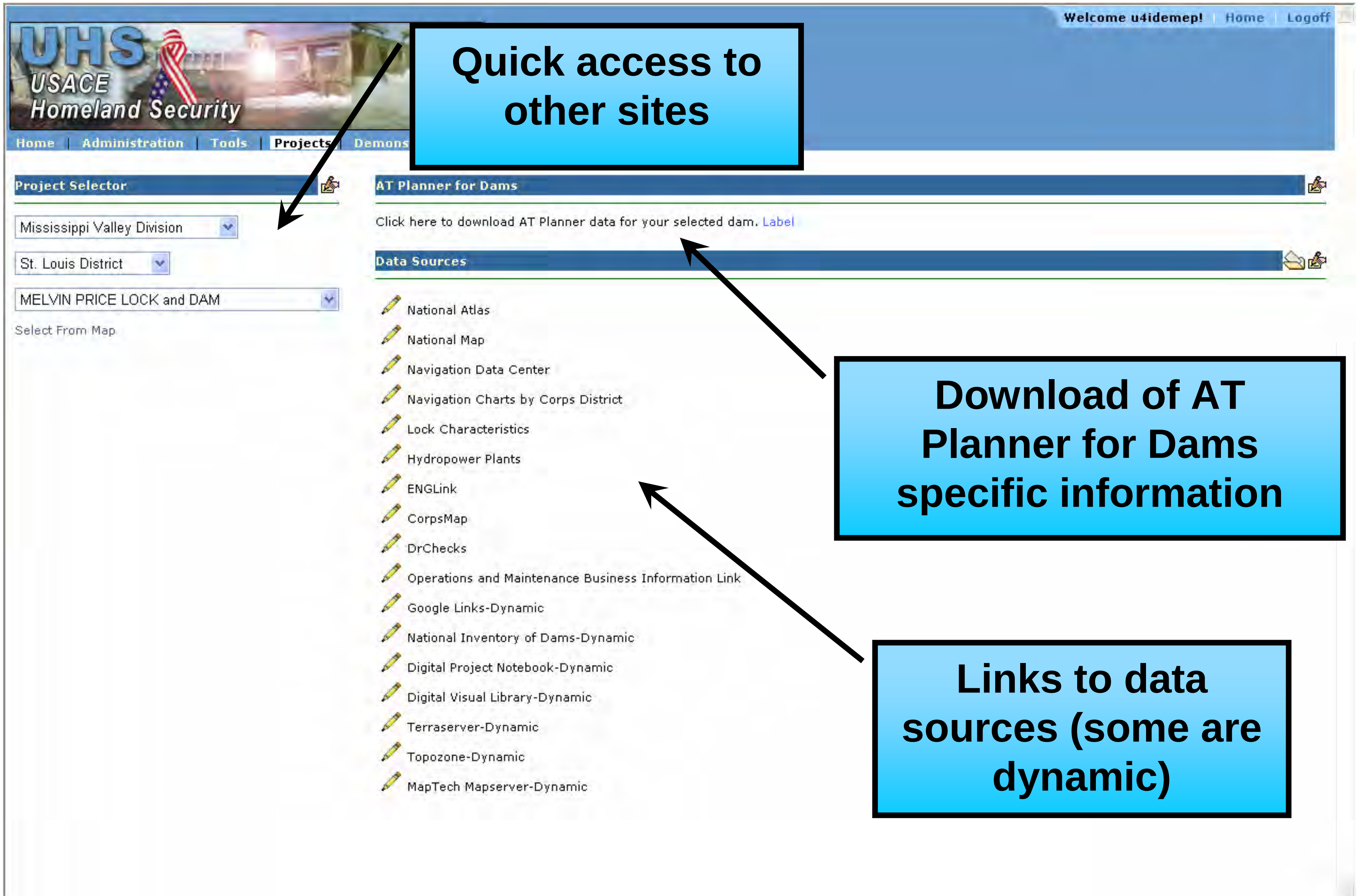
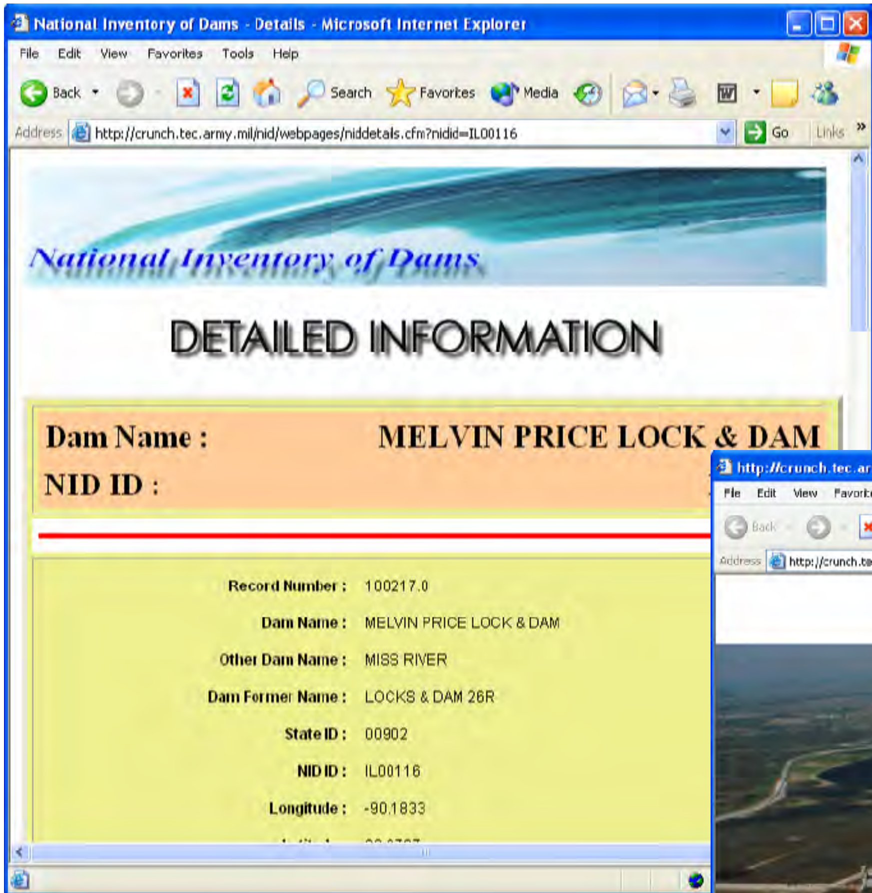
Installation and Operation
Example Problems
Technical Documents

Project Info

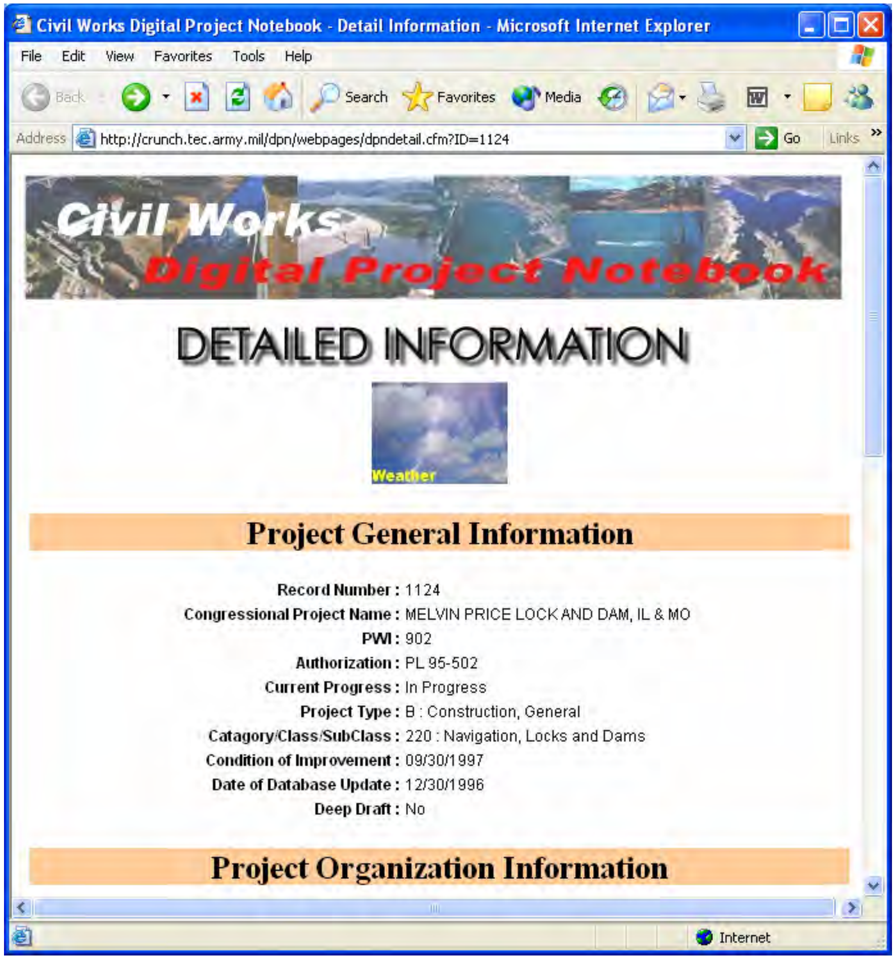


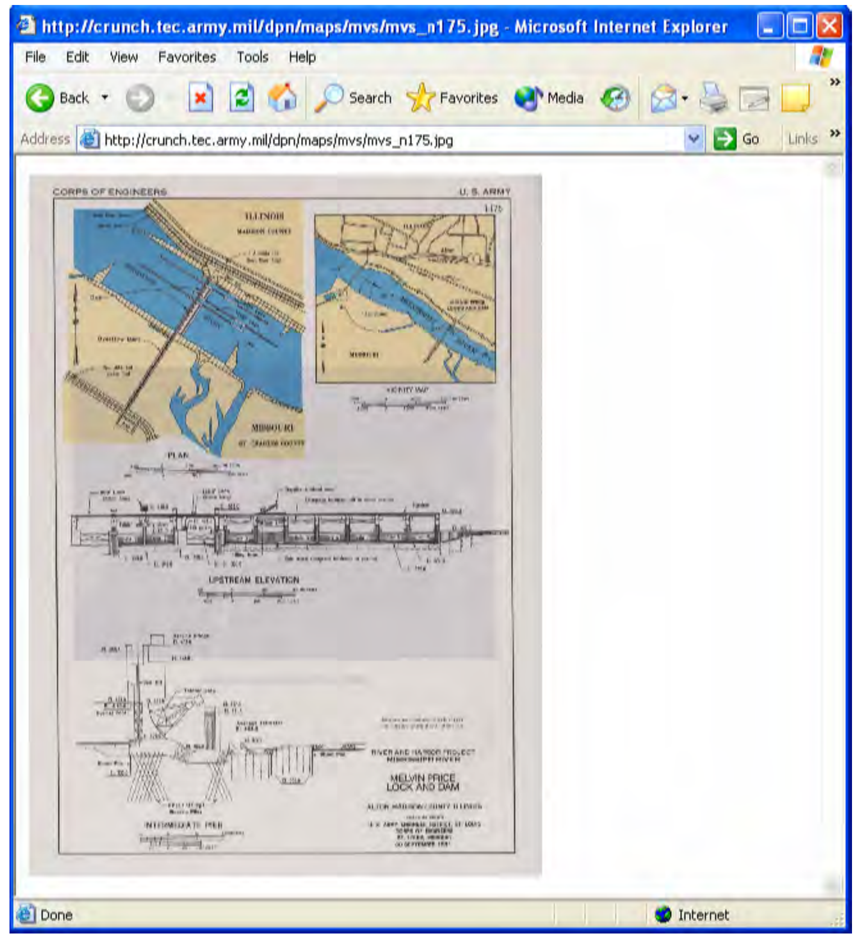
Project Info (NID)



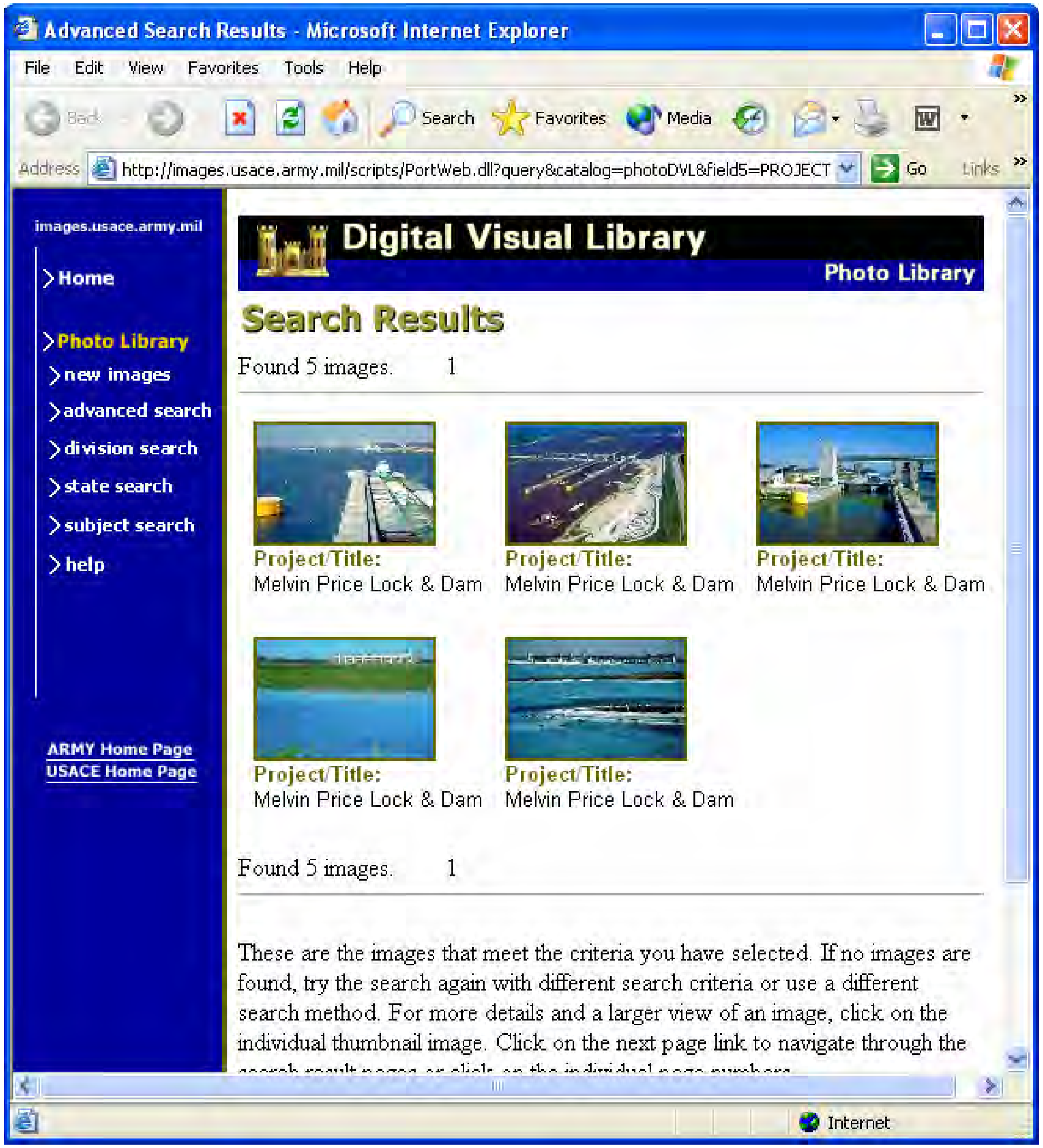
ERDC Engineer Research and Development Center

Project Info (DPN)

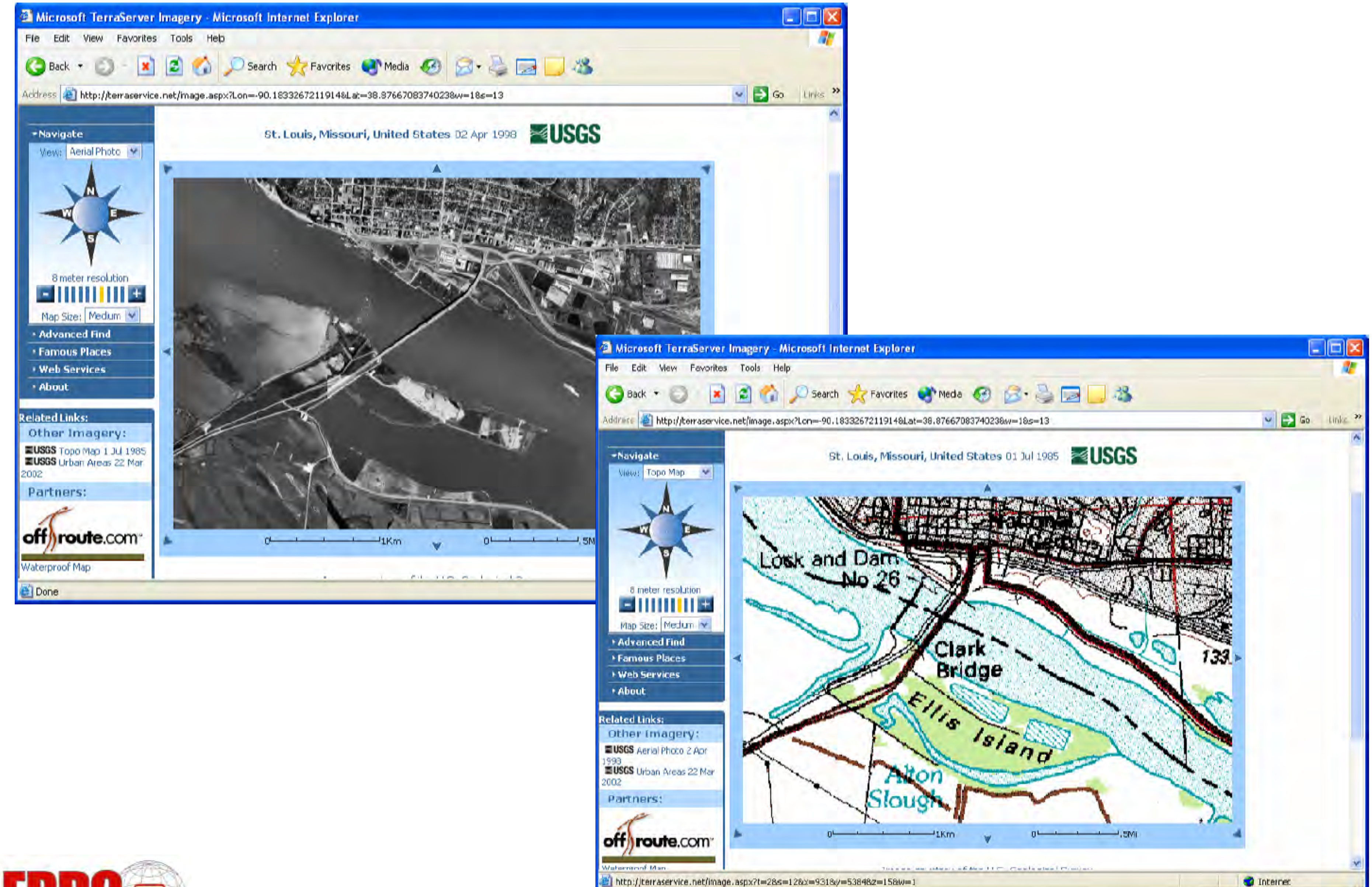




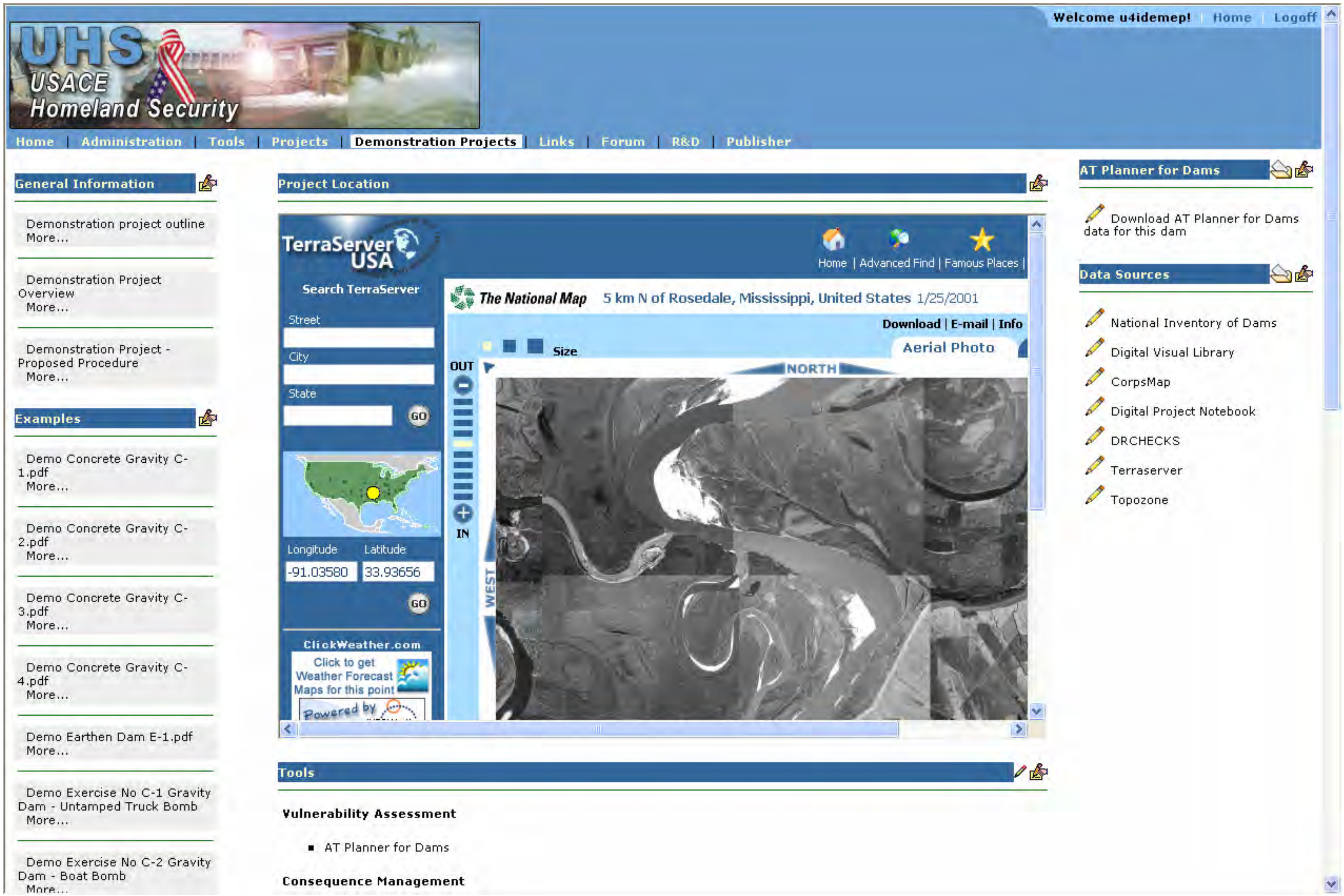
Project Info (DVL)



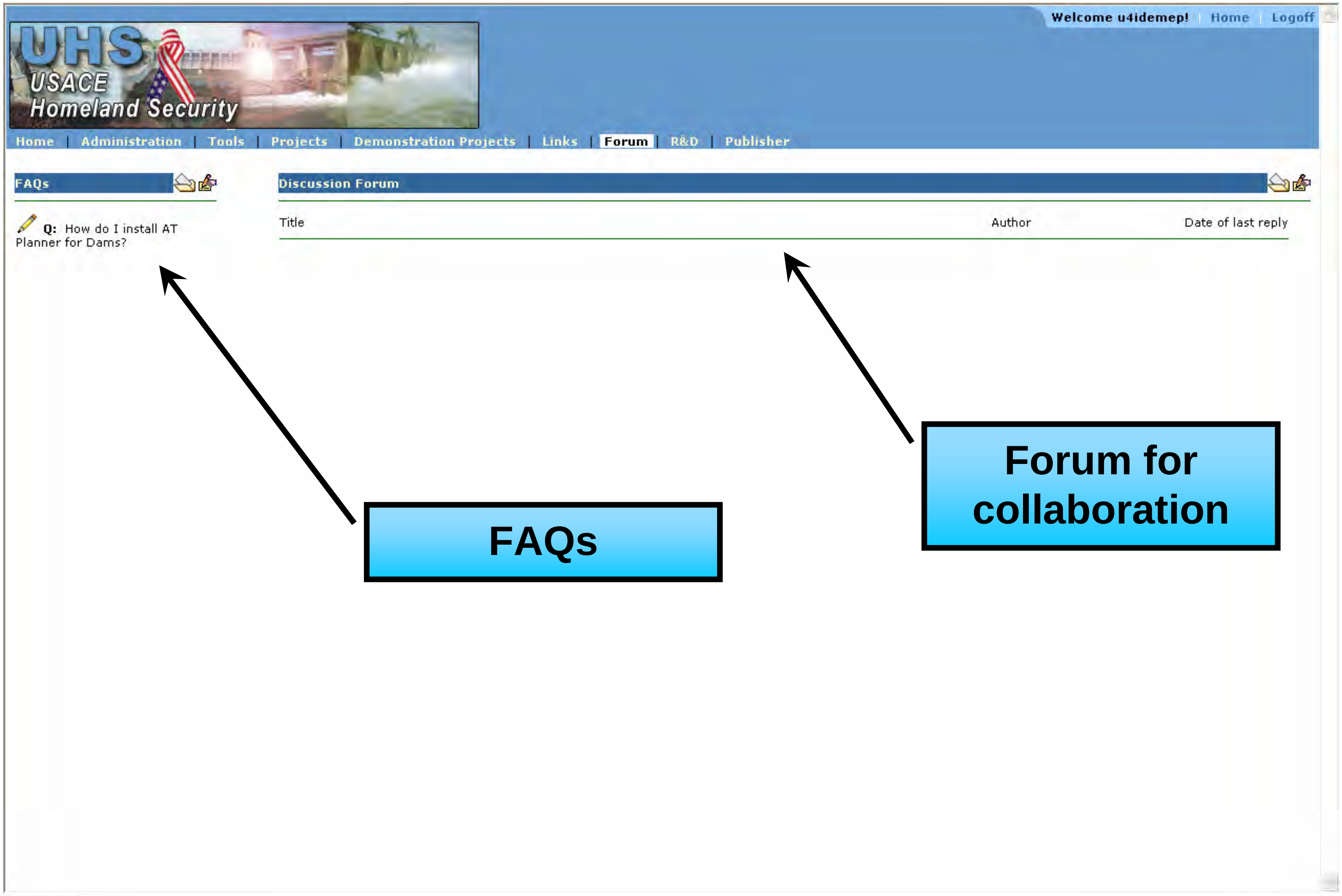
Project Info (TerraServer)



Demonstration Project



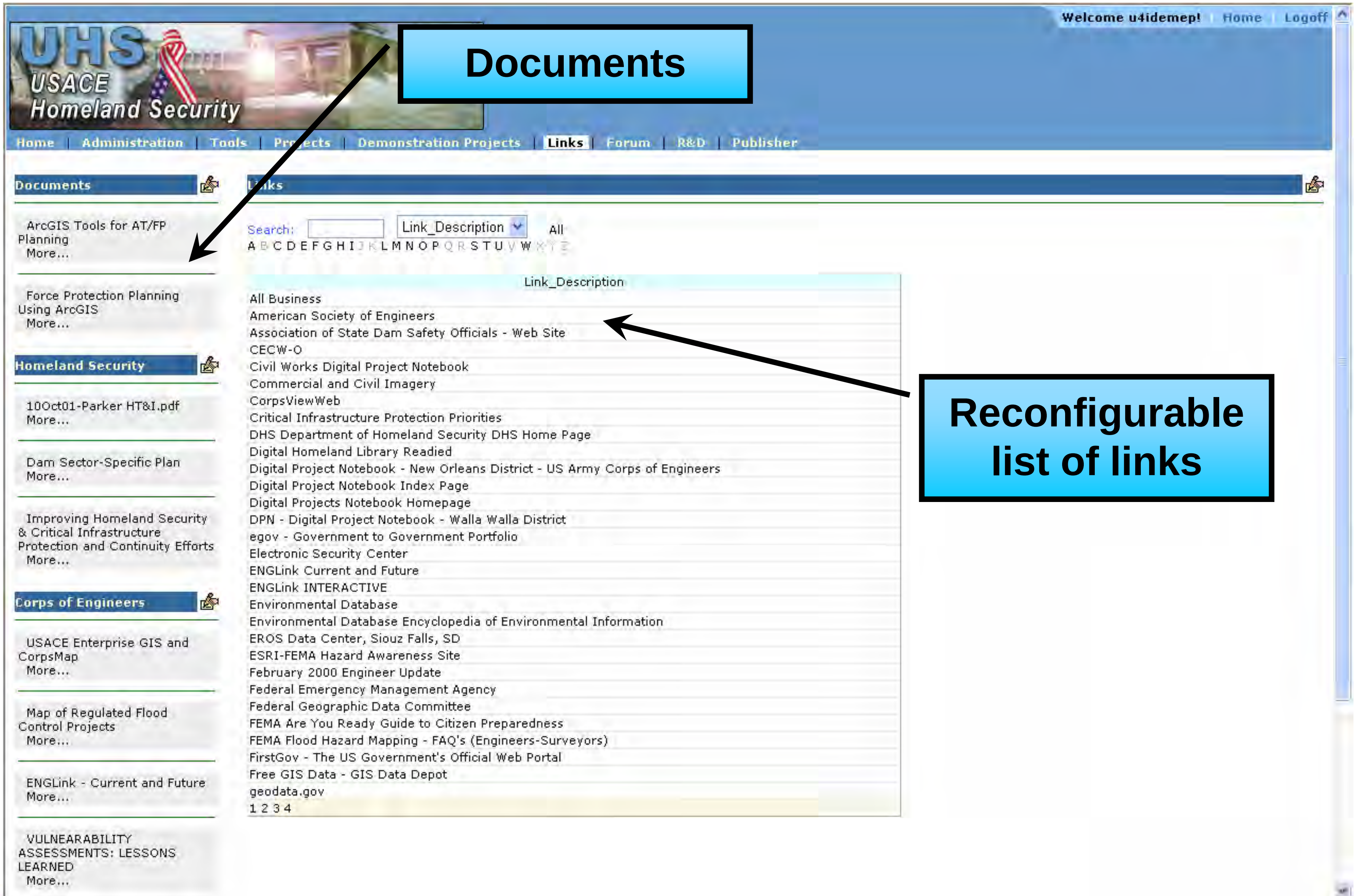
FAQs and Forum



FAQs

Forum for collaboration

Links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Force Protection Planning Using ArcGIS
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Homeland Security
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Dam Sector-Specific Plan
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Improving Homeland Security & Critical Infrastructure Protection and Continuity Efforts
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USACE Enterprise GIS and CorpsMap
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Map of Regulated Flood Control Projects
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ENGLink - Current and Future
More...
VULNEARABILITY ASSESSMENTS: LESSONS LEARNED
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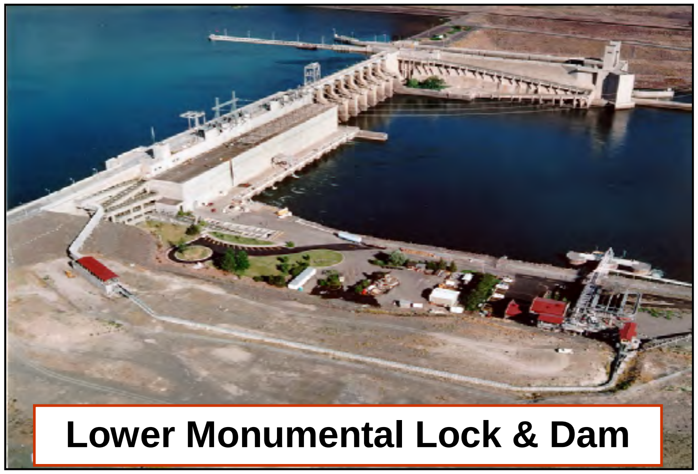
Association of State Dam Safety Officials - Web Site
CECW-O
Civil Works Digital Project Notebook
Commercial and Civil Imagery
CorpsViewWeb
Critical Infrastructure Protection Priorities
DHS Department of Homeland Security DHS Home Page
Digital Homeland Library Readied
Digital Project Notebook - New Orleans District - US Army Corps of Engineers
Digital Project Notebook Index Page
Digital Projects Notebook Homepage
DPN - Digital Project Notebook - Walla Walla District
egov - Government to Government Portfolio
Electronic Security Center
ENGLink Current and Future
ENGLink INTERACTIVE
Environmental Database
Environmental Database Encyclopedia of Environmental Information
EROS Data Center, Sioux Falls, SD
ESRI-FEMA Hazard Awareness Site
February 2000 Engineer Update
Federal Emergency Management Agency
Federal Geographic Data Committee
FEMA Are You Ready Guide to Citizen Preparedness
FEMA Flood Hazard Mapping - FAQ's (Engineers-Surveyors)
FirstGov - The US Government's Official Web Portal
Free GIS Data - GIS Data Depot
geodata.gov
1 2 3 4
Documents
Reconfigurable list of links

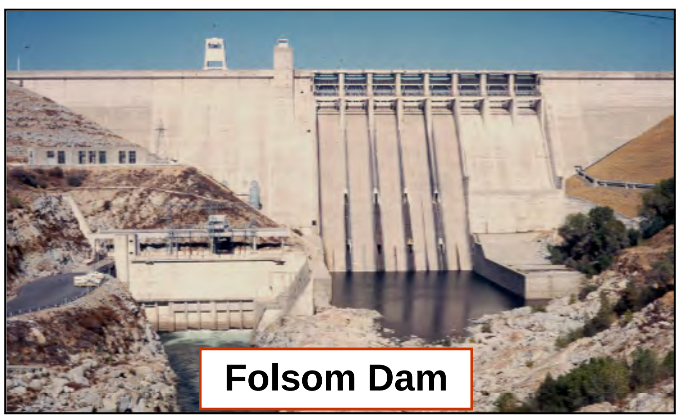
Future R&D

R&D in support to Baseline Security Posture and USACE Homeland Security Strategic Plan (FY07-11).



Lower Monumental Lock & Dam

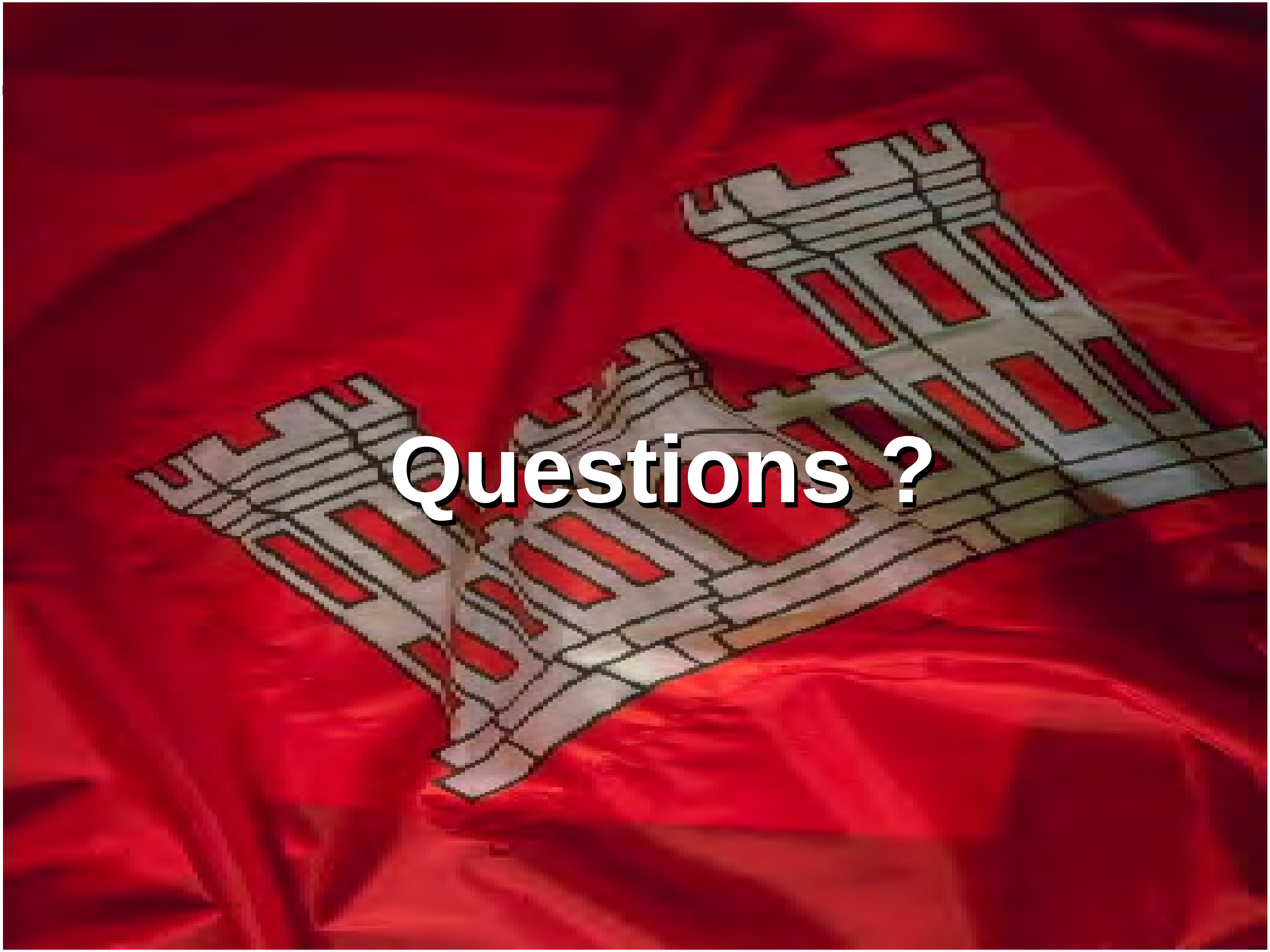
- **Integrated assessment procedures.**
- **Standardized risk/vulnerability procedures for evaluation of post-BSP security upgrades.**



Folsom Dam

Summary

- Portal will provide:
  - Features
    - Secure easy access
    - Collaboration tools (forum), Lite GIS, Content management, Automated retrieval of data
  - Documents and Data
    - Data for district projects (RAM-D reports, design documents, ATP-D data files, etc.)
    - Sources of data (ENGLink, DPN, Corps sites, NSDI clearinghouse nodes, etc.)
  - Tools
    - RAM-D, ATP-D, R&D tools, other security related tools


Questions ?

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CEBIS

Features

DATABASE TOOLS FOR CIVIL WORKS PROJECTS

Database Systems

- ***COMPONENTS***
- ***IMPLEMENTATION***
- ***CEBIS***

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Database System Development

Purpose

- ❖MEET REQUIREMENTS
- ❖GATHER DATA
- ❖MONITORING
- ❖DATA REDUCTION
- ❖DECISION MAKING
- ❖ARCHIVING

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Database System Development

Considerations

- ❖PURPOSE/GOALS
- ❖FORMAT
- ❖STANDARDIZE
- ❖SIMPLIFY
- ❖CONSISTANCY
- ❖EFFICIENCY

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Database System Development

Standardization

- ❖RECORDING
- ❖REPORTING
- ❖REVIEW

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Database System Development

Web Based

1. ***Advantages***
   a. Follow the Trend
   b. Easy Updates/Maintenance
   c. Greater Administrative Control/Access
   d. Centralized Database

2. ***Disadvantages***
   a. Reliability
   b. Less Local Control
   c. Limitations

Database Systems

IMPLEMENTATION

- ❖**Acceptance**
- ❖**Useful**
  - ❖**All Levels**
- ❖**Cost Effective**

Database Systems

INSPECTION TOOL

- ❖Get Work Done
- ❖Increase Efficiency/Effectiveness
- ❖Consistency

CEBIS Features

DEVELOPMENT

- Meet Reporting Requirements
- Update Existing Program
- Plagiarize
- Address Complaints
- Web Based
- Implemented in 2005

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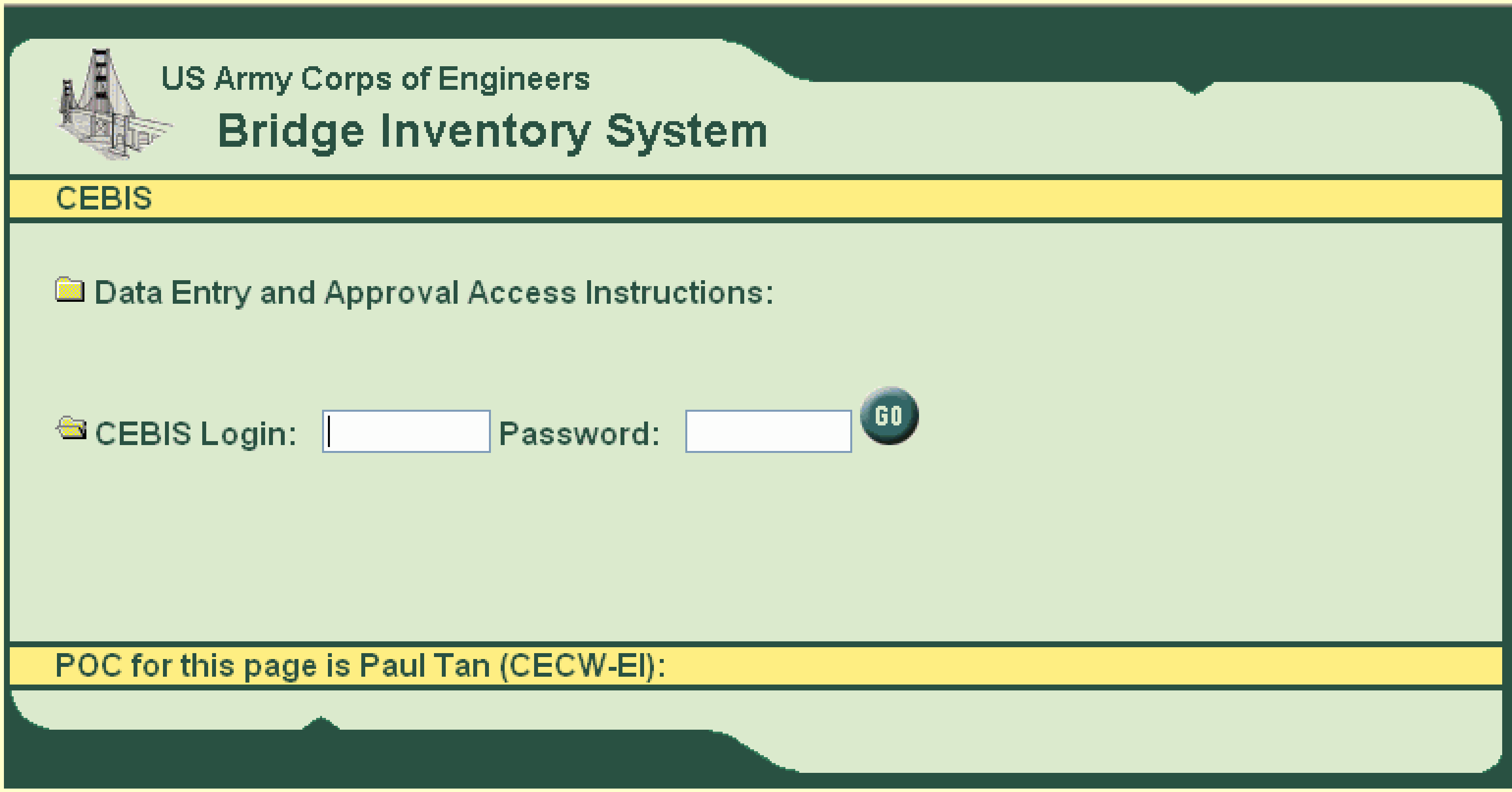
CEBIS Features

DEVELOPMENT

- Incorporate ER
  - References
  - Criteria
  - Standards

- Introduction
- Considerations
- Implementation
- CEBIS
- Features

CEBIS Features



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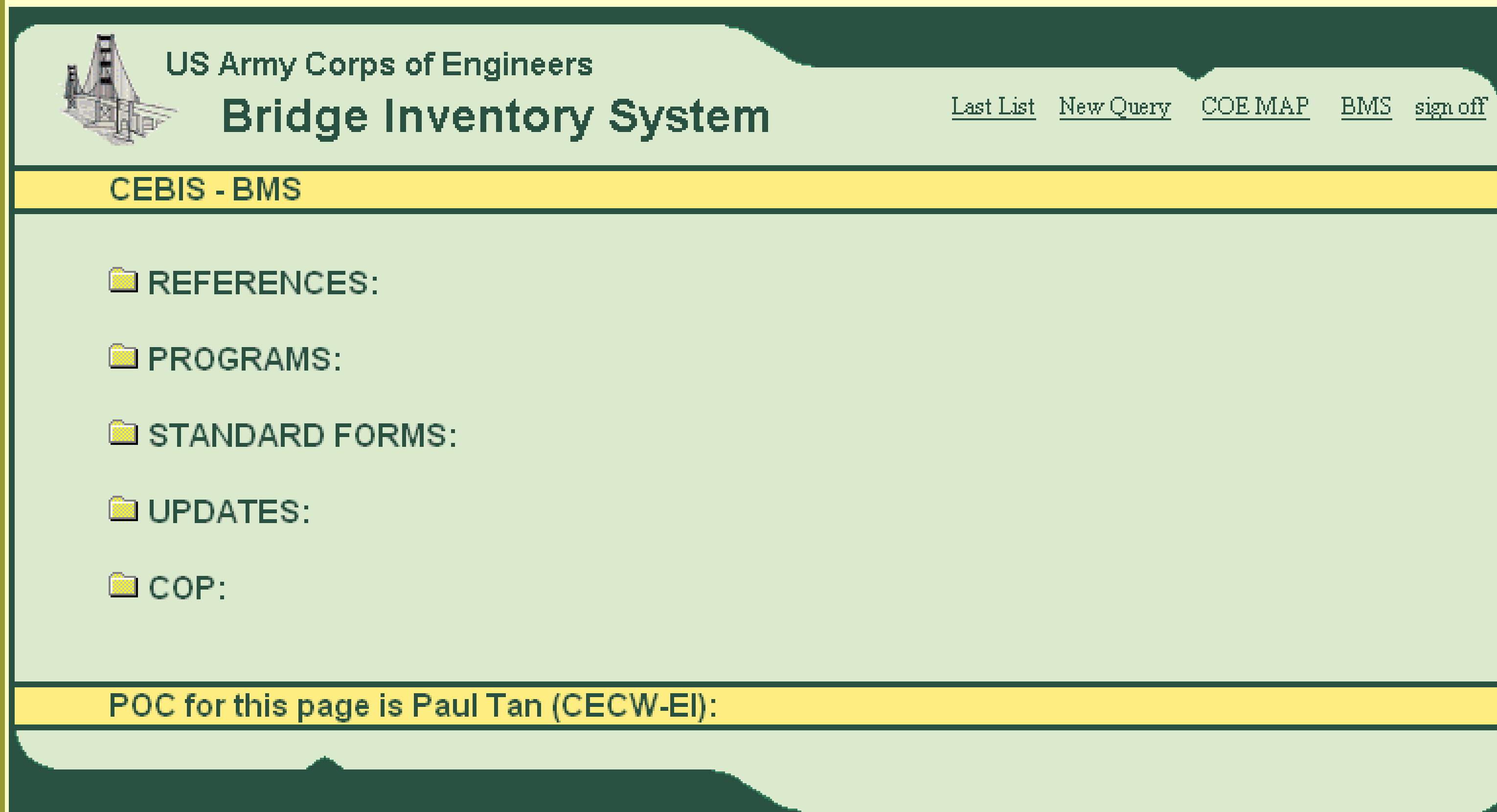
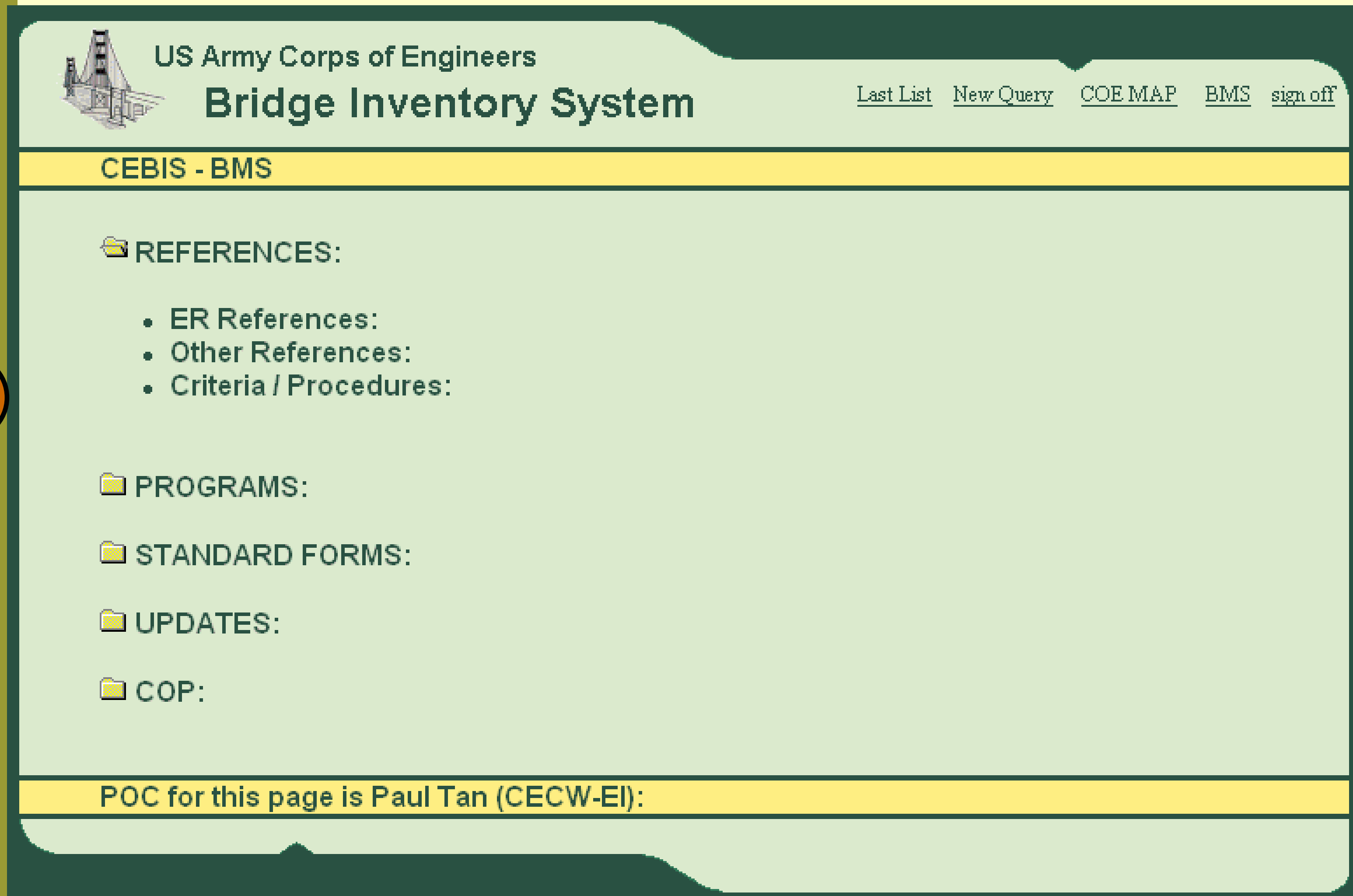
CEBIS Features



CEBIS Features

- Introduction
- Considerations
- Implementation
- **CEBIS**
- Features



CEBIS Features

US Army Corps of Engineers

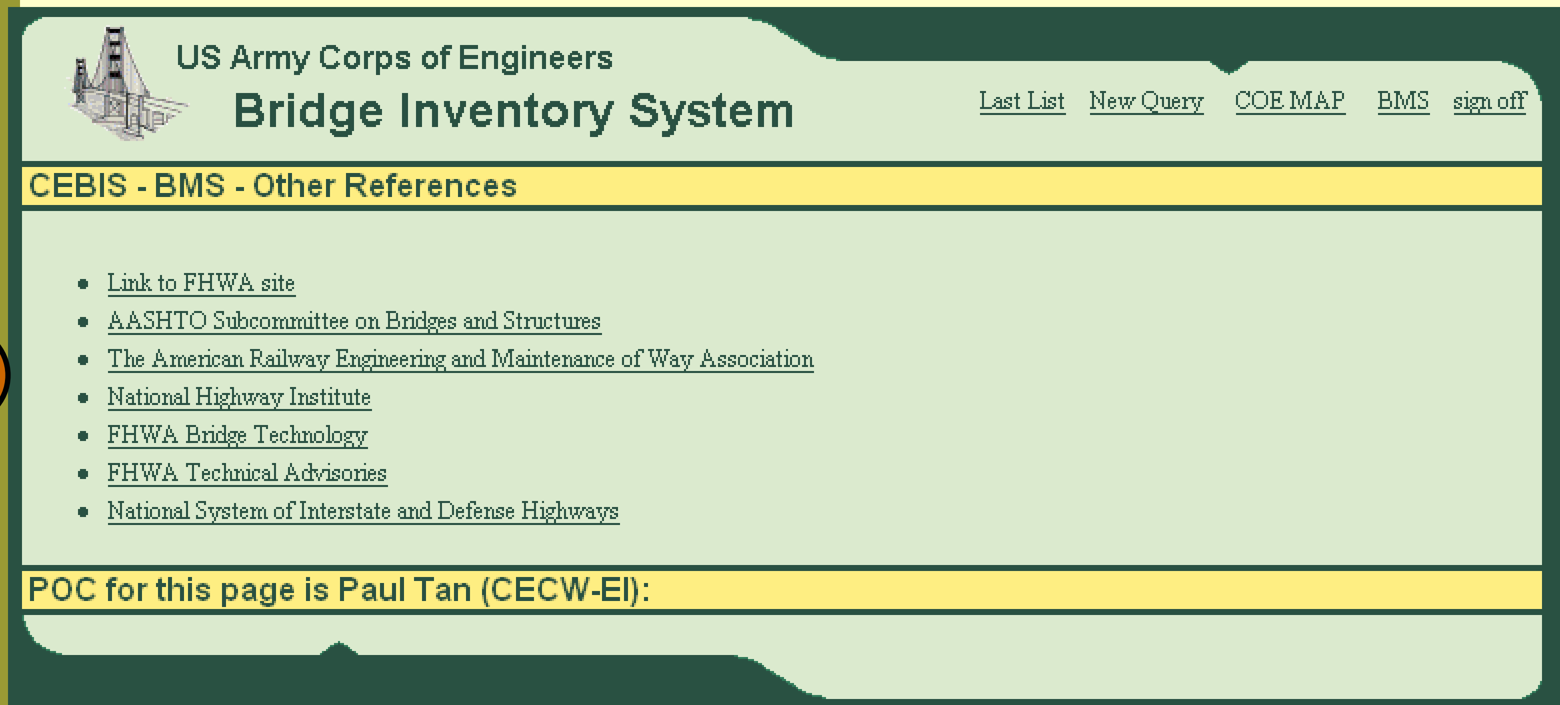
Bridge Inventory System

Last List | New Query | COE MAP | BMS | sign off

CEBIS - BMS - ER References

- 23 F.R. 650, "National Bridge Inspection Standard," December 2004.
- ER 1110-2-100, Periodic Inspection and Continuing Evaluation of Completed Civil Works Structures.
- ER 1110-2-101, Reporting of Evidence of Distress of Civil Works Structures.
- EM 385-1-1, Safety and Health Requirements Manual.
- "AASHTO LRFD Bridge Design Specifications" (latest edition).
- "Bridge Inspector's Reference Manual," October, 2002 , Federal Highway Administration, 6300 Georgetown Pike, McLean, VA 22101.
- "Movable Bridge Inspection, Evaluation, and Maintenance Manual," AASHTO, 1998
- "Construction and Maintenance Section," American Railway Engineering Association, Volumes I & II.
- "Culvert Inspection Manual," Federal Highway Administration, FHWA-IP-86-2, July 01, 1986.
- "Evaluating Scour at Bridges," FHWA Technical Advisory T5140.23, October 28, 1991.
- "Evaluating Scour at Bridges," Hydraulic Engineering Circular (HEC) 18, Federal Highway Administration, FHWA-NHI-01-001, May 01, 2001.
- "Stream Stability at Highway Structures, Third Edition", Hydraulic Engineering Circular (HEC) 20, Federal Highway Administration, FHWA-NHI-01-001, March, 2001.
- "Bridge Scour And Stream Instability Countermeasures", Hydraulic Engineering Circular (HEC) 23, Federal Highway Administration, FHWA-NHI-01-001, March, 2001.
- "Guide Specifications for Design of Pedestrian Bridges" (latest edition), American Association of State Highway and Transportation Officials.
- "Guide Specifications for Fatigue Evaluation of Existing Steel Bridges," American Association of State Highway and Transportation Officials, 1990.
- "Inspection of Fracture Critical Bridge Members," Federal Highway Administration, FHWA-IP-86-2, September 01, 1986, supplement to reference 4f.
- "Manual for Condition Evaluation and Load and Resistance Factor Rating (LRFR) of Highway Bridges," American Association of State Highway and Transportation Officials, 444 N. Capitol Street NW, Washington, DC 20001 (latest edition).
- "Manual for Railway Engineering," American Railway Engineering and Maintenance-of-Way Association, Volumes I & II (latest edition).
- OSHA Standard 1926.106(a), Personal Protective and Life Saving Equipment, "Standards Interpretation, Fall Protection, Lifejacket, and Lifesaving Requirements When Working Over or Near Water."
- "Recording and Coding Guide for the Structure Inventory and Appraisal of the Nations Bridges," Design and Inspection Branch,

CEBIS Features


US Army Corps of Engineers
Bridge Inventory System

Last List | New Query | COE MAP | BMS | sign off

CEBIS - BMS - Other References

- Link to FHWA site
- AASHTO Subcommittee on Bridges and Structures
- The American Railway Engineering and Maintenance of Way Association
- National Highway Institute
- FHWA Bridge Technology
- FHWA Technical Advisories
- National System of Interstate and Defense Highways

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Last List New Query COE MAP BMS sign off

CEBIS - BMS - Criteria / Procedures

- Load Rating
- Scour Evaluations - Procedures/Plans of Action
- Fracture / Fatigue
- Seismic Evaluations
- Emergency Procedures
- Follow Up / Monitor Critical Findings
- Inspection Intervals
- Railway Brdiges
- Inspection Types
- QC/QA Procedures

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CEBIS - BMS

REFERENCES:

PROGRAMS:

STANDARD FORMS:

- QCP/5-Year Plan
- Scour Monitoring
- FCM Plan
- QA Checklist
- QC Checklist

UPDATES:

COP:

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CEBIS - BMS

REFERENCES:

PROGRAMS:

STANDARD FORMS:

UPDATES:

- Comments
- Search Program Changes:
- Most Recent Changes:
- Standard Procedure Changes
- Interim Policy Changes

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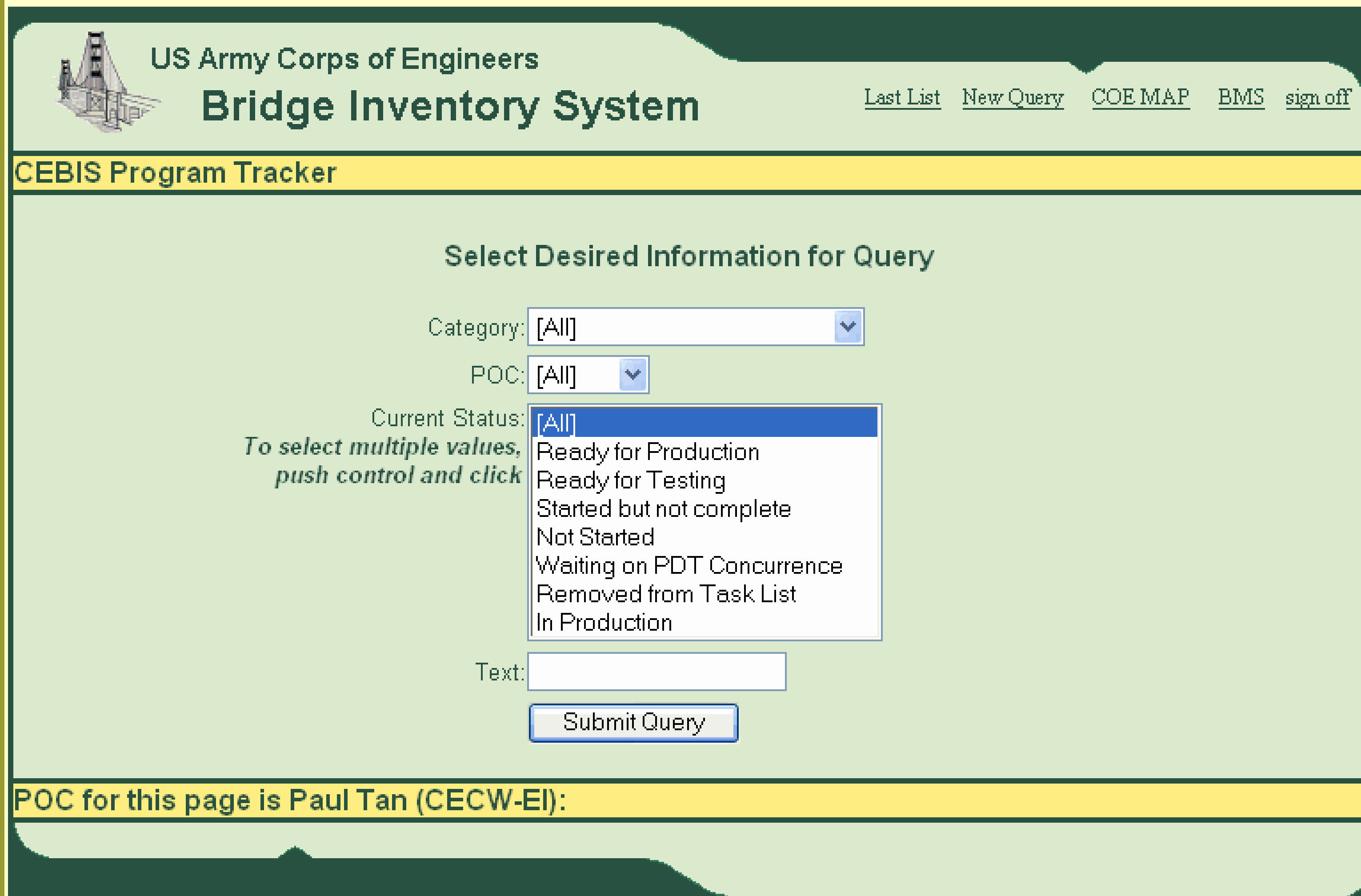
- Features



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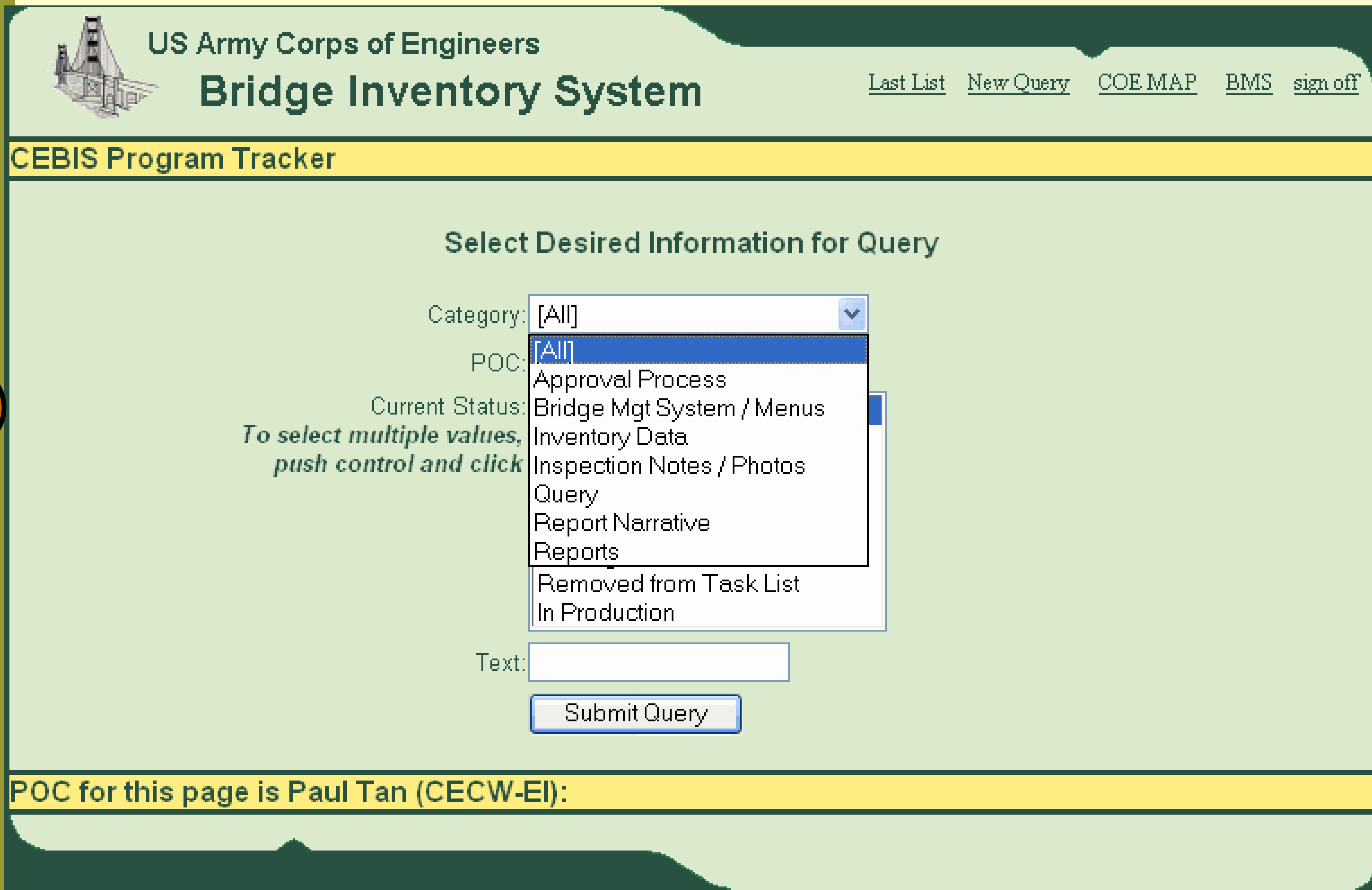

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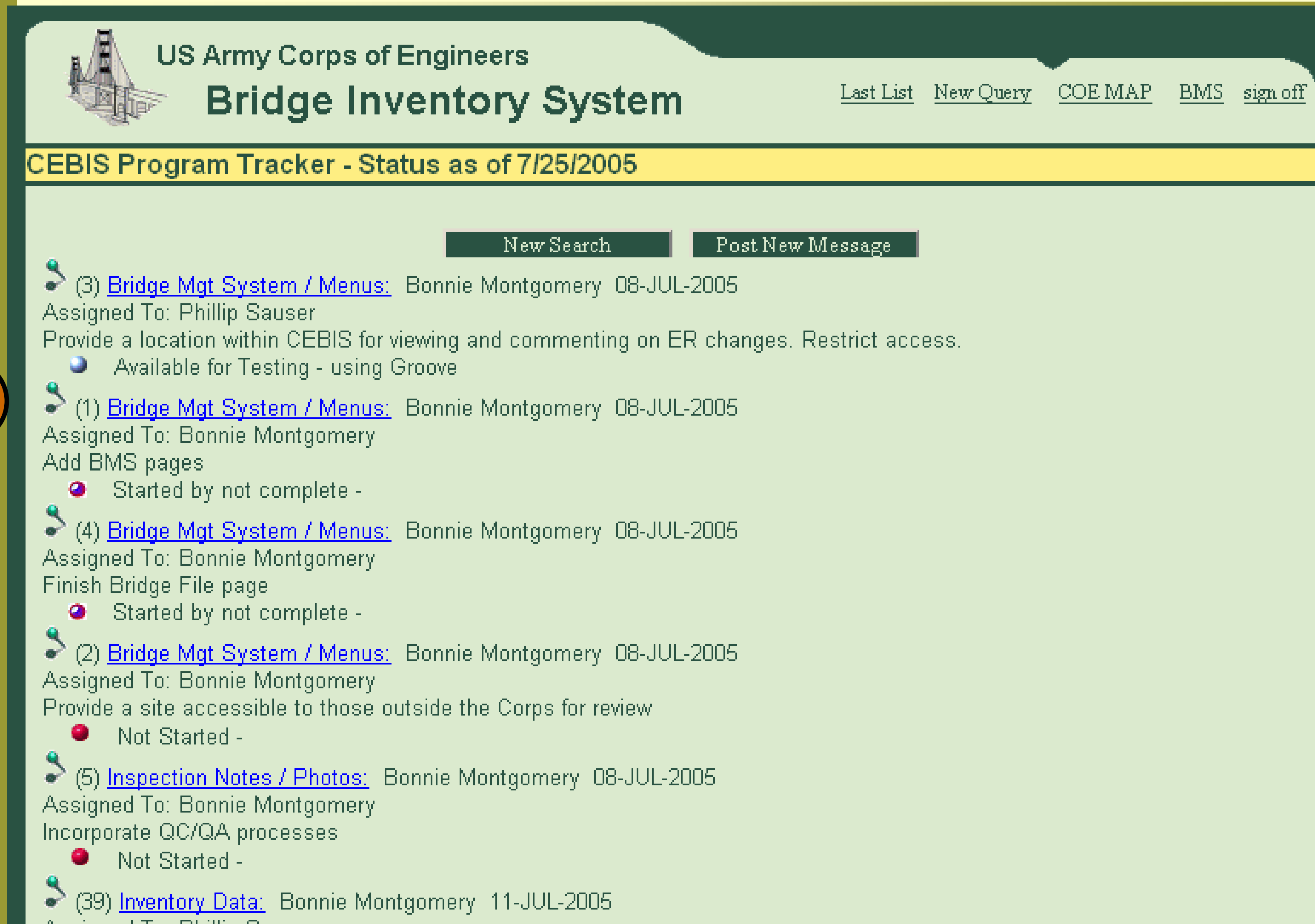

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REFERENCES:

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STANDARD FORMS:

UPDATES:

- Comments
- Search Program Changes:
- Most Recent Changes:
- Standard Procedure Changes
- Interim Policy Changes

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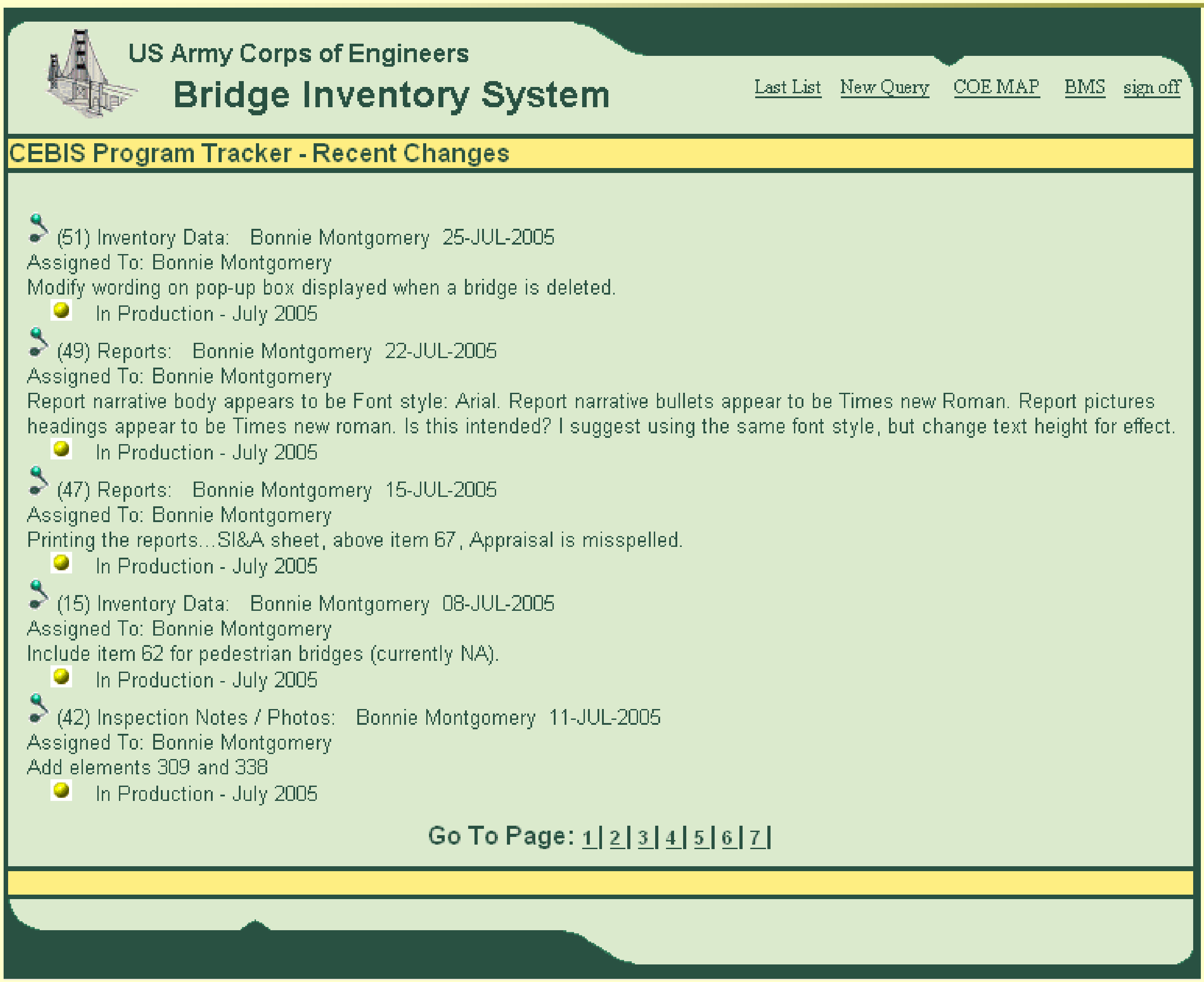

US Army Corps of Engineers

Bridge Inventory System

Last List | New Query | COE MAP | BMS | sign off

CEBIS Program Tracker - Recent Changes

(51) Inventory Data: Bonnie Montgomery 25-JUL-2005
Assigned To: Bonnie Montgomery
Modify wording on pop-up box displayed when a bridge is deleted.
- In Production - July 2005

(49) Reports: Bonnie Montgomery 22-JUL-2005
Assigned To: Bonnie Montgomery
Report narrative body appears to be Font style: Arial. Report narrative bullets appear to be Times new Roman. Report pictures headings appear to be Times new roman. Is this intended? I suggest using the same font style, but change text height for effect.
- In Production - July 2005

(47) Reports: Bonnie Montgomery 15-JUL-2005
Assigned To: Bonnie Montgomery
Printing the reports...SI&A sheet, above item 67, Appraisal is misspelled.
- In Production - July 2005

(15) Inventory Data: Bonnie Montgomery 08-JUL-2005
Assigned To: Bonnie Montgomery
Include item 62 for pedestrian bridges (currently NA).
- In Production - July 2005

(42) Inspection Notes / Photos: Bonnie Montgomery 11-JUL-2005
Assigned To: Bonnie Montgomery
Add elements 309 and 338
- In Production - July 2005

Go To Page: 1 | 2 | 3 | 4 | 5 | 6 | 7 |

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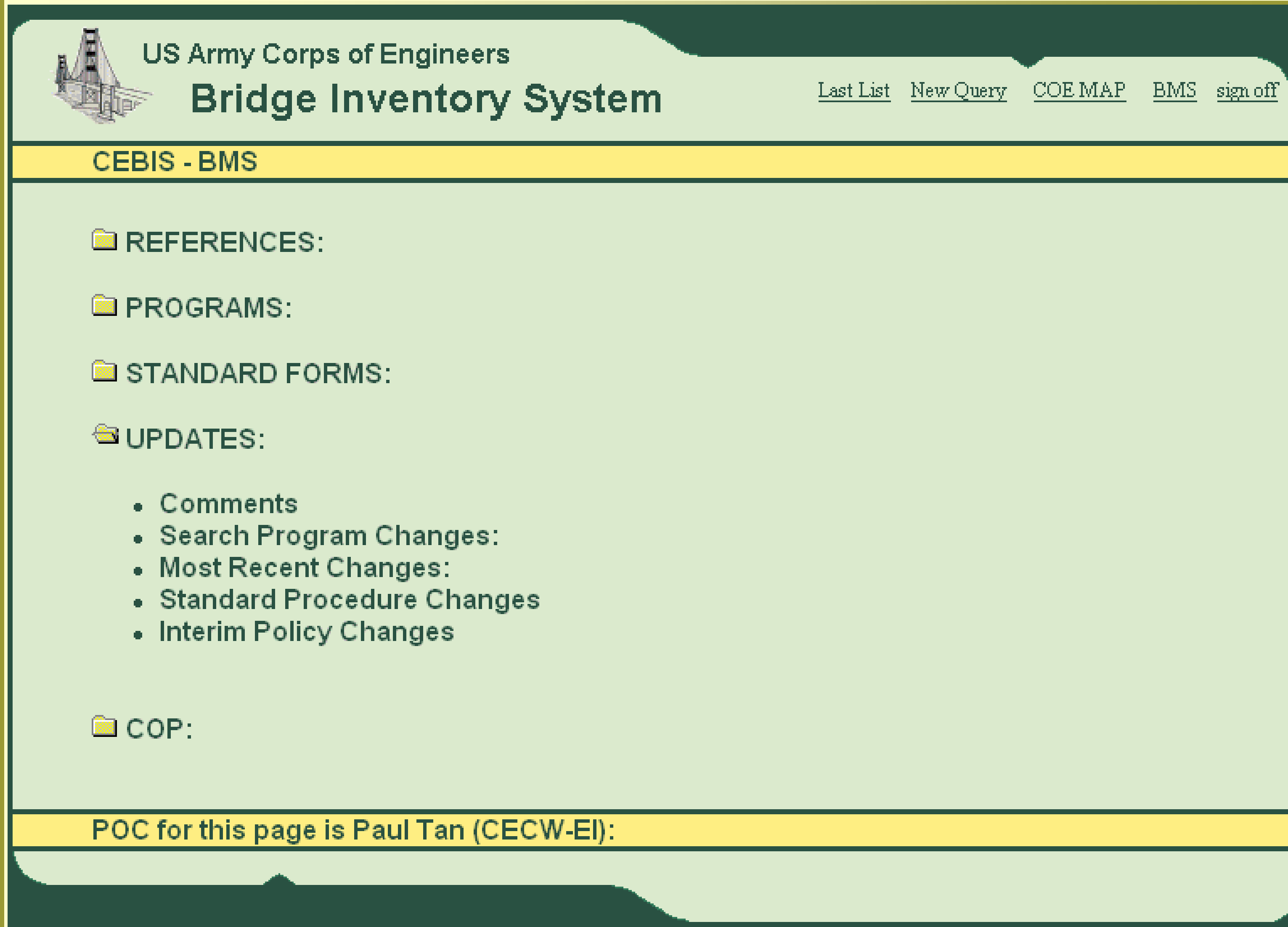

CEBIS Features

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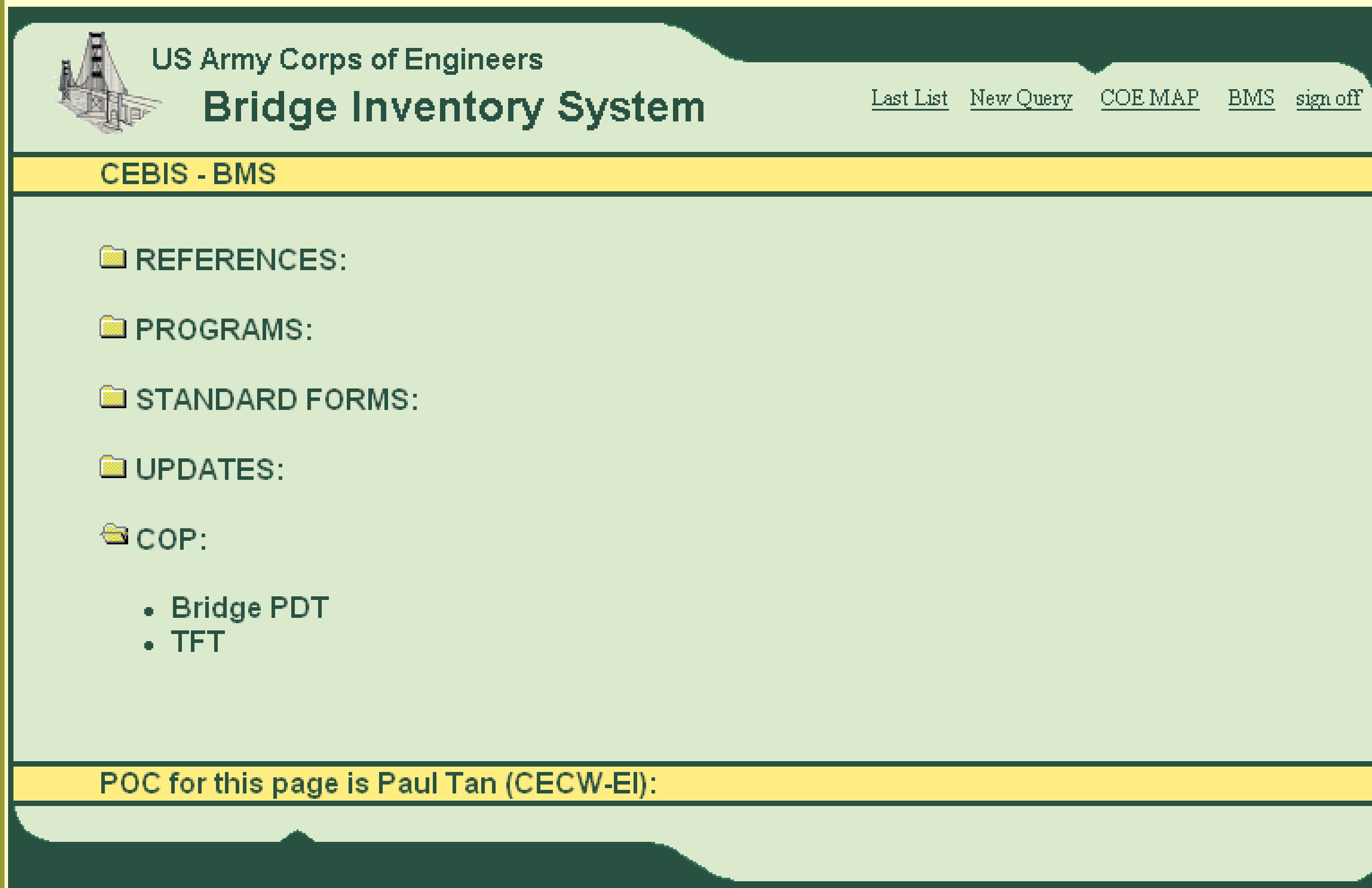

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Bridge Inventory System

Last List New Query COE MAP BMS sign off

CEBIS - BMS - COP - PDT

- Paul Tan, HQUSACE
- Thomas Tam, NAD
- Robert Fulton SAD
- Robert Taylor, LRD
- Ken Klaus, MVD
- John Morris, SWD
- Victor Yan, SPD
- Bruce McCracken, NWD
- Allen Taira, POD
- Phil Sauser, MVP

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CEBIS - BMS

REFERENCES:

PROGRAMS:

- CEBIS - user manual
- Problem Reporting
- Access Instructions
- Load Rating
- Fatigue

STANDARD FORMS:

UPDATES:

COP:

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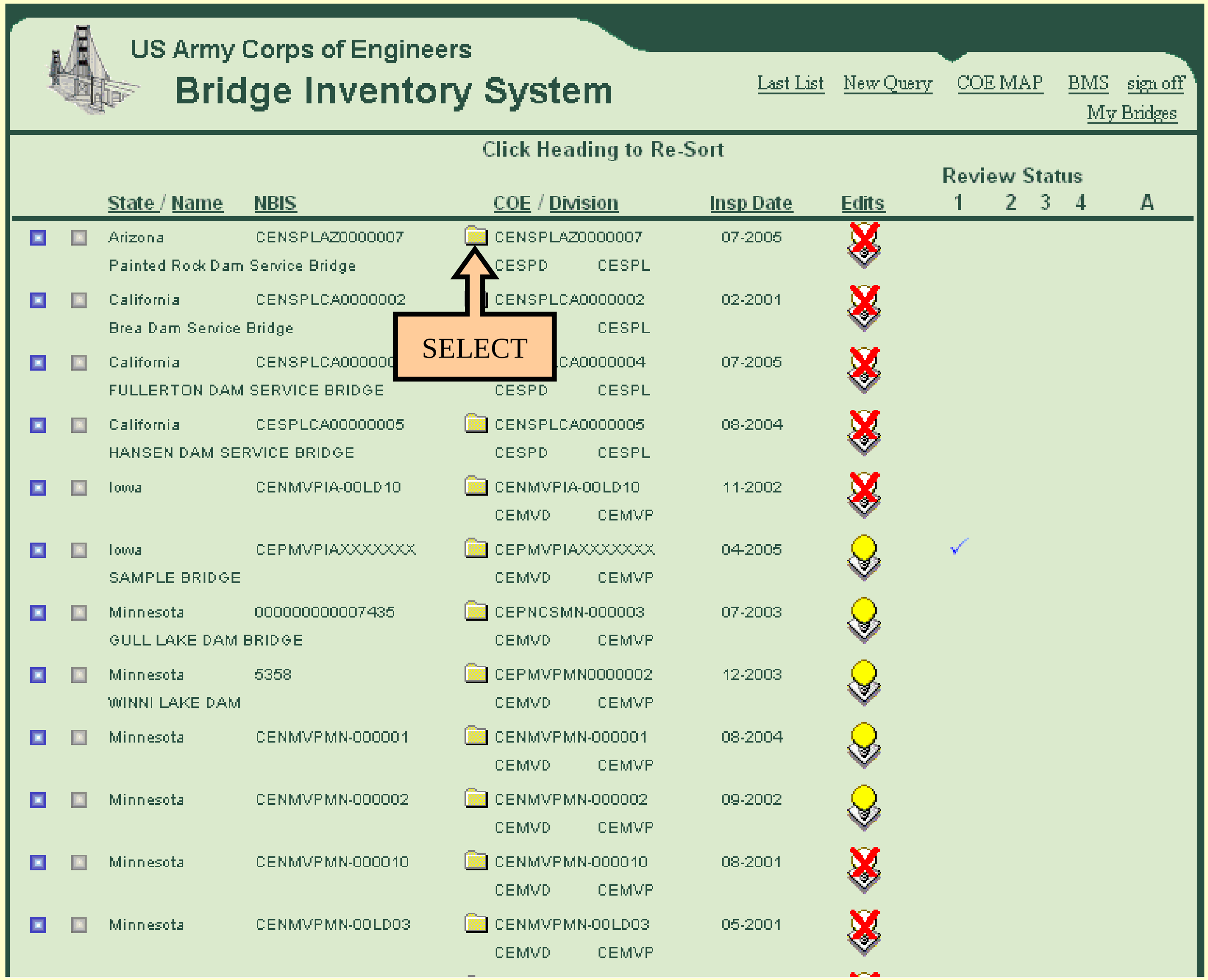

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California Brea Dam Service Bridge	CENSPLCA0000002	CENSPLCA0000002 CESPL	02-2001						
California FULLERTON DAM SERVICE BRIDGE	CENSPLCA000000	CA0000004 CESPD CESPL	07-2005						
California HANSEN DAM SERVICE BRIDGE	CESPLCA00000005	CENSPLCA0000005 CESPD CESPL	08-2004						
Iowa	CENMVPIA-00LD10	CENMVPIA-00LD10 CEMVD CEMVP	11-2002						
Iowa SAMPLE BRIDGE	CEPMVPIAXXXXXXX	CEPMVPIAXXXXXXX CEMVD CEMVP	04-2005		✓				
Minnesota GULL LAKE DAM BRIDGE	000000000007435	CEPNCSMN-000003 CEMVD CEMVP	07-2003						
Minnesota WINNI LAKE DAM	5358	CEPMVPMN0000002 CEMVD CEMVP	12-2003						
Minnesota	CENMVPMN-000001	CENMVPMN-000001 CEMVD CEMVP	08-2004						
Minnesota	CENMVPMN-000002	CENMVPMN-000002 CEMVD CEMVP	09-2002						
Minnesota	CENMVPMN-000010	CENMVPMN-000010 CEMVD CEMVP	08-2001						
Minnesota	CENMVPMN-00LD03	CENMVPMN-00LD03 CEMVD CEMVP	05-2001						

CEBIS Features

- *Introduction*
- *Considerations*
- *Implementation*
- *CEBIS*
- *Features*

US Army Corps of Engineers

Bridge Inventory System

Query COE MAP sign off

My Bridges Error Report Add COE Bridge

Structure Number	Name	NBI Structure Number
CEPNCSMN-000003	GULL LAKE DAM BRIDGE	000000000007435

Bridge File

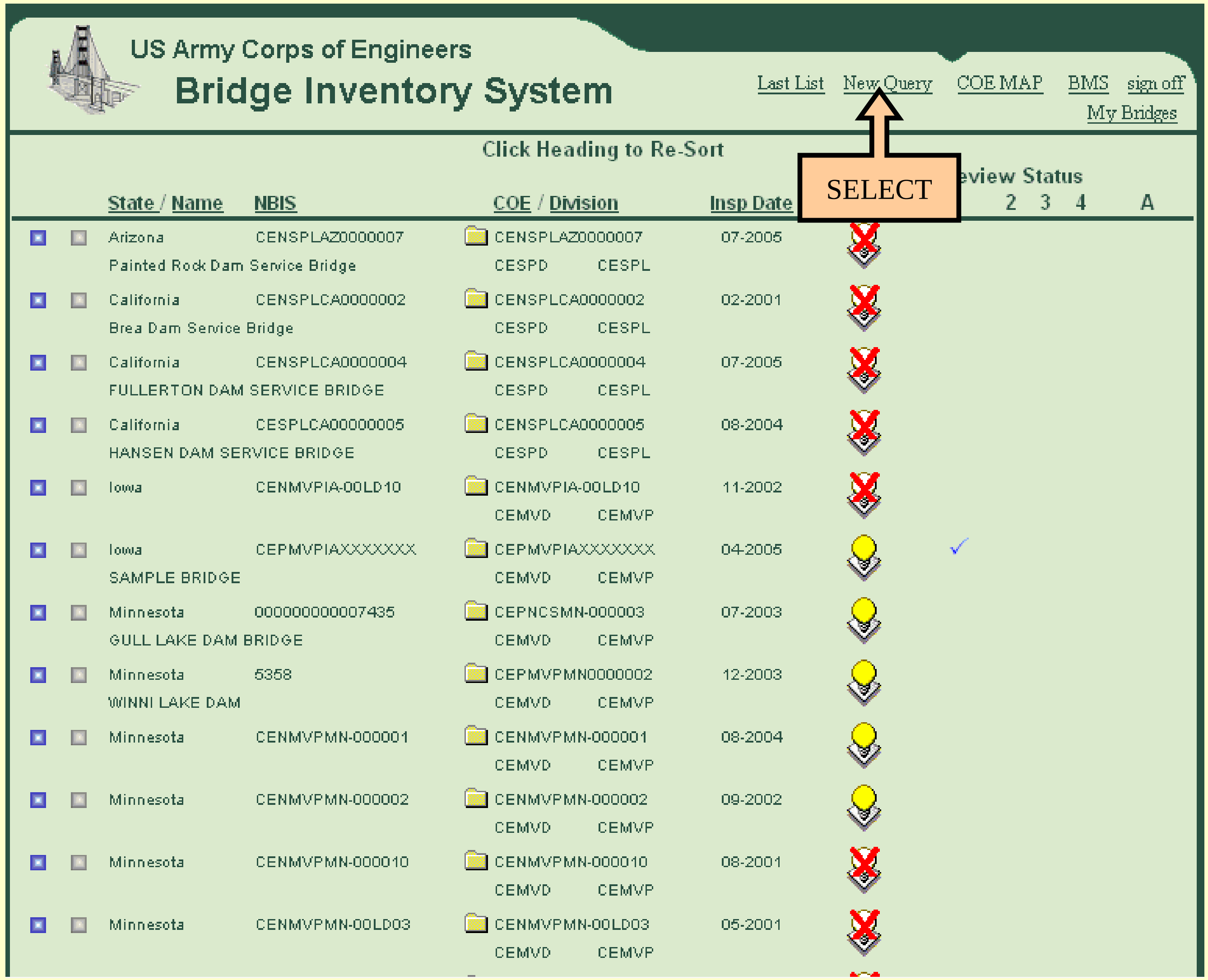
COMPONENTS

Plans: 0 files, 0 KB.	Plans, shop, and/or as-built drwgs avail. and on file
Specifications: 0 files, 0 KB.	Specs available and on file
Correspondence: 0 files, 0 KB.	Pertinent to bridge history, chronological order
Photos: 0 files, 0 KB.	Plan, elevation, and other pertinent photos
Materials and Tests: 0 files, 0 KB.	Material certs & test data avail. & on file
Maintenance and Repair History: 0 files, 0 KB.	Chronol. record documenting maint. and repairs
Coating History: 0 files, 0 KB.	Prep, application, thick., & types of paint & protec.
Accident Records: 0 files, 0 KB.	Dates, descrip., damage, repairs, and reports
Posting: 0 files, 0 KB.	Summary of posting actions, calcs, date, signs
Permit Loads: 0 files, 0 KB.	Record of significant special single trip permits
Flood Data: 0 files, 0 KB.	History of major events, high water, scour
Traffic Data: 0 files, 0 KB.	History of variation & types of traffic
Inspection History: 0 files, 0 KB.	Chronological record of dates & types
Inspection Requirements: 0 files, 0 KB.	Lists of tools, equip., special details, safety & traffic
SI&A Sheet: 0 files, 0 KB.	Chronological record of SI&A sheets
Inventories and Inspections: 0 files, 0 KB.	Reports & results of all other inventories & inspec.
Rating Records: 0 files, 0 KB.	Complete record of load capacity determination

INSPECTION DATA

Inspection Reports: 0 files, 0 KB.	Previous to automaticly generated CEBIS reports
Waterway Adequacy: 0 files, 0 KB.	Item 79 & 113
Channel Profile: 0 files, 0 KB.	Show foundation info. & changes over time
Restrictions on Structure: 0 files, 0 KB.	Load, speed, or traffic
Utility Attachments: 0 files, 0 KB.	Attached and in ROW

CEBIS Features



US Army Corps of Engineers
Bridge Inventory System

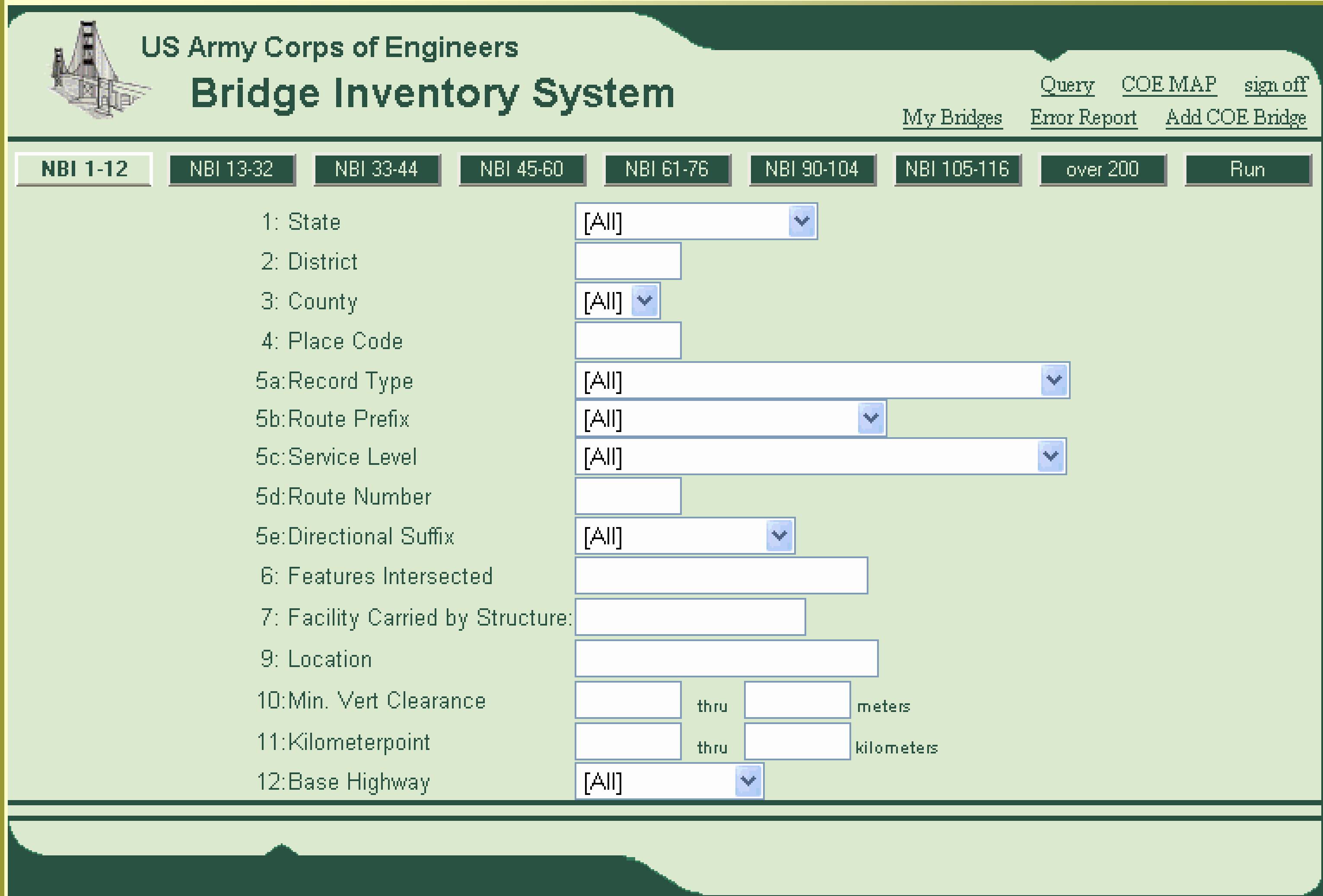
Last List | New Query | COE MAP | BMS | sign off | My Bridges

SELECT

Click Heading to Re-Sort

State / Name	NBIS	COE / Division	Insp Date	Review Status 2 3 4 A
Arizona Painted Rock Dam Service Bridge	CENSPLAZ0000007	CENSPLAZ0000007 CESPD CESPL	07-2005	
California Brea Dam Service Bridge	CENSPLCA0000002	CENSPLCA0000002 CESPD CESPL	02-2001	
California FULLERTON DAM SERVICE BRIDGE	CENSPLCA0000004	CENSPLCA0000004 CESPD CESPL	07-2005	
California HANSEN DAM SERVICE BRIDGE	CESPLCA00000005	CENSPLCA0000005 CESPD CESPL	08-2004	
Iowa	CENMVPIA-00LD10	CENMVPIA-00LD10 CEMVD CEMVP	11-2002	
Iowa SAMPLE BRIDGE	CEPMVPIAXXXXXXX	CEPMVPIAXXXXXXX CEMVD CEMVP	04-2005	✓
Minnesota GULL LAKE DAM BRIDGE	000000000007435	CEPNCSMN-000003 CEMVD CEMVP	07-2003	
Minnesota WINNI LAKE DAM	5358	CEPMVPMN0000002 CEMVD CEMVP	12-2003	
Minnesota	CENMVPMN-000001	CENMVPMN-000001 CEMVD CEMVP	08-2004	
Minnesota	CENMVPMN-000002	CENMVPMN-000002 CEMVD CEMVP	09-2002	
Minnesota	CENMVPMN-000010	CENMVPMN-000010 CEMVD CEMVP	08-2001	
Minnesota	CENMVPMN-00LD03	CENMVPMN-00LD03 CEMVD CEMVP	05-2001	

CEBIS Features



US Army Corps of Engineers
Bridge Inventory System

Query | COE MAP | sign off
My Bridges | Error Report | Add COE Bridge

NBI 1-12 | NBI 13-32 | NBI 33-44 | NBI 45-60 | NBI 61-76 | NBI 90-104 | NBI 105-116 | over 200 | Run

1: State [All]
2: District
3: County [All]
4: Place Code
5a: Record Type [All]
5b: Route Prefix [All]
5c: Service Level [All]
5d: Route Number
5e: Directional Suffix [All]
6: Features Intersected
7: Facility Carried by Structure:
9: Location
10: Min. Vert Clearance thru meters
11: Kilometerpoint thru kilometers
12: Base Highway [All]

CEBIS Features

US Army Corps of Engineers
Bridge Inventory System

Query | COE MAP | sign off
My Bridges | Error Report | Add COE Bridge

Click Heading to Re-Sort

State / Name	NBIS	COE / Division	Insp Date	Edits	Review Status 1	2	3	4	A
Minnesota GULL LAKE DAM BRIDGE	000000000007435	CEPNCSMN-000003 CEMVD CEMVP	07-2003						2004
Minnesota WINNI LAKE DAM	5358	CEPMVPMN0000002 CEMVD CEMVP	12-2003						2004
Minnesota	CEPNCSMN-000002	CEPNCSMN-000002 CEMVD CEMVP	12-2003						2004
Minnesota Lac Qui Parle Dam	CEPNCSMN-000004	CEPNCSMN-000004 CEMVD CEMVP	09-2004						2004
Minnesota Chippewa River Diversion	CEPNCSMN-000005	CEPNCSMN-000005 CEMVD CEMVP	10-2003						2004
Minnesota Watson Sag	CEPNCSMN-000006	CEPNCSMN-000006 CEMVD CEMVP	10-2003						2004
Minnesota Browns Valley Culvert	CEPNCSMN-000007	CEPNCSMN-000007 CEMVD CEMVP	09-2004		✓	✓	✓	✓	2004
North Dakota EGGERTS LANDING BRIDGE	CEPNCSND-00BH02	CEPNCSND-00BH02 CEMVD CEMVP	09-2004		✓	✓	✓	✓	2004
South Dakota	CEPNCSSD-000008	CEPNCSSD-000008 CEMVD CEMVP	06-2004						2004

Bridge Count: 9

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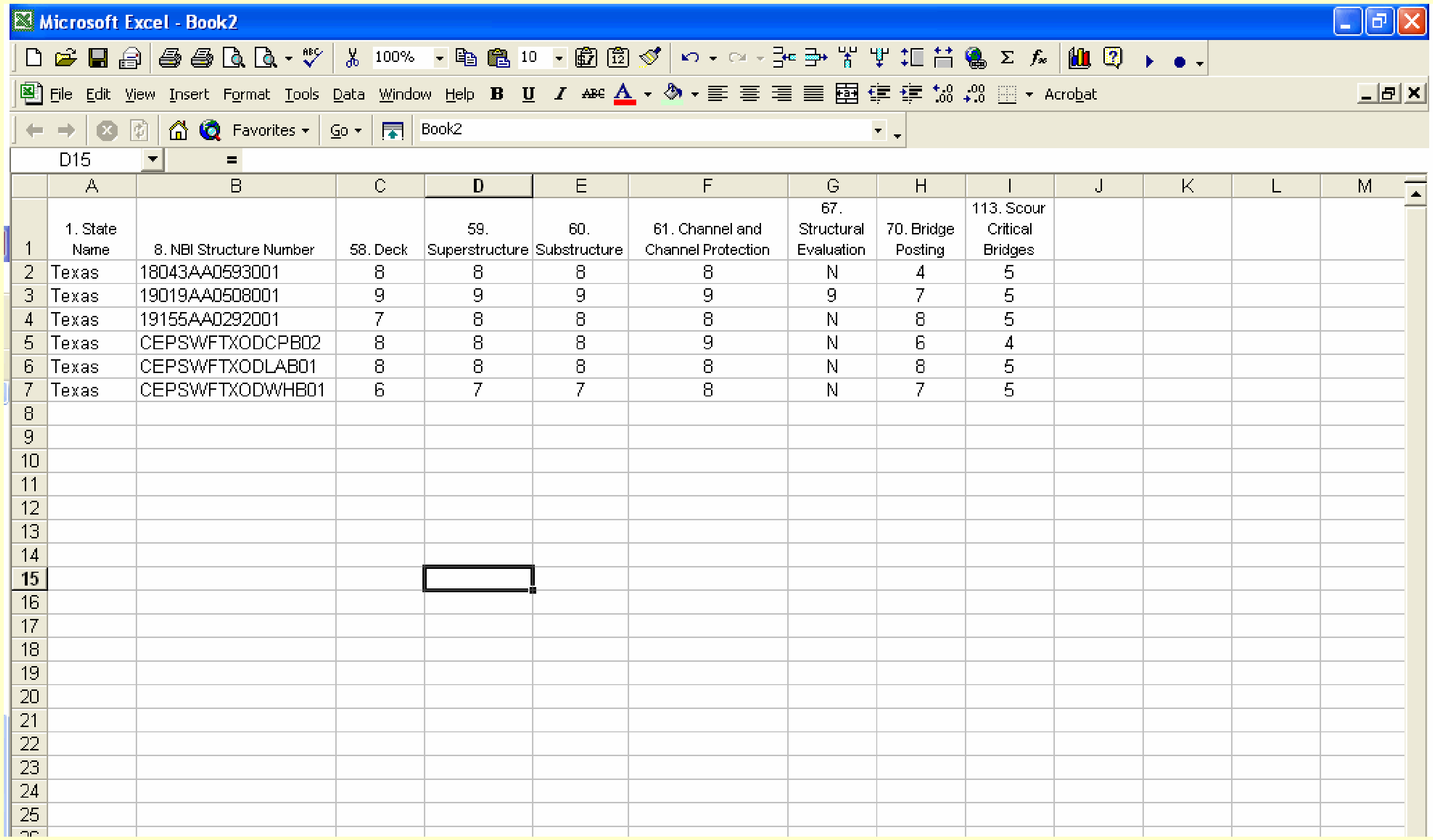

	A	B	C	D	E	F	G	H	I
1	1. State Name	8. NBI Structure Number	58. Deck	59. Superstructure	60. Substructure	61. Channel and Channel Protection	67. Structural Evaluation	70. Bridge Posting	113. Scour Critical Bridges
2	Texas	18043AA0593001	8	8	8	8	N	4	5
3	Texas	19019AA0508001	9	9	9	9	9	7	5
4	Texas	19155AA0292001	7	8	8	8	N	8	5
5	Texas	CEPSWFTXODCPB02	8	8	8	9	N	6	4
6	Texas	CEPSWFTXODLAB01	8	8	8	8	N	8	5
7	Texas	CEPSWFTXODWHB01	6	7	7	8	N	7	5

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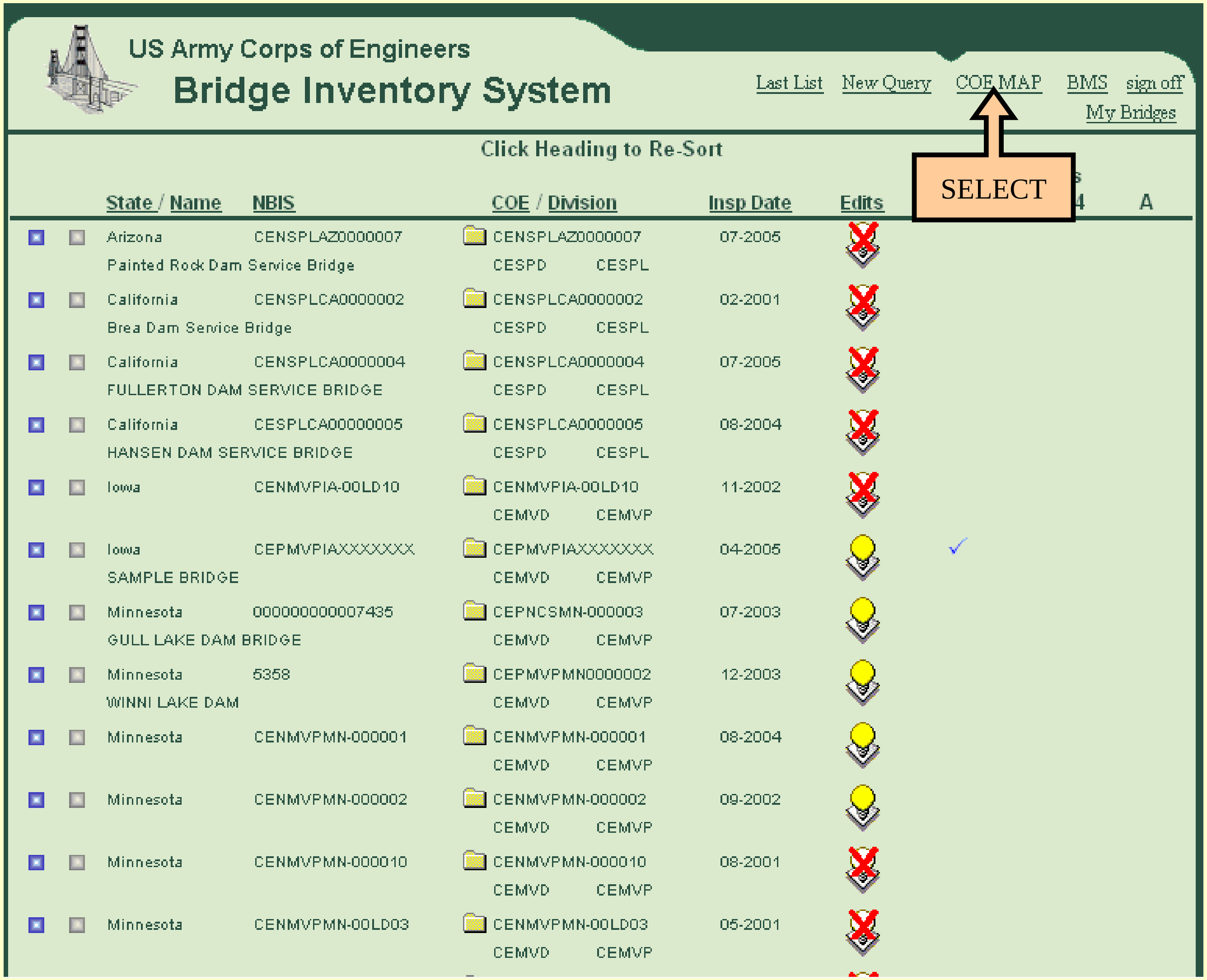

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Minnesota	CENMVPMN-000002	CENMVPMN-000002 CEMVD CEMVP	09-2002	
Minnesota	CENMVPMN-000010	CENMVPMN-000010 CEMVD CEMVP	08-2001	
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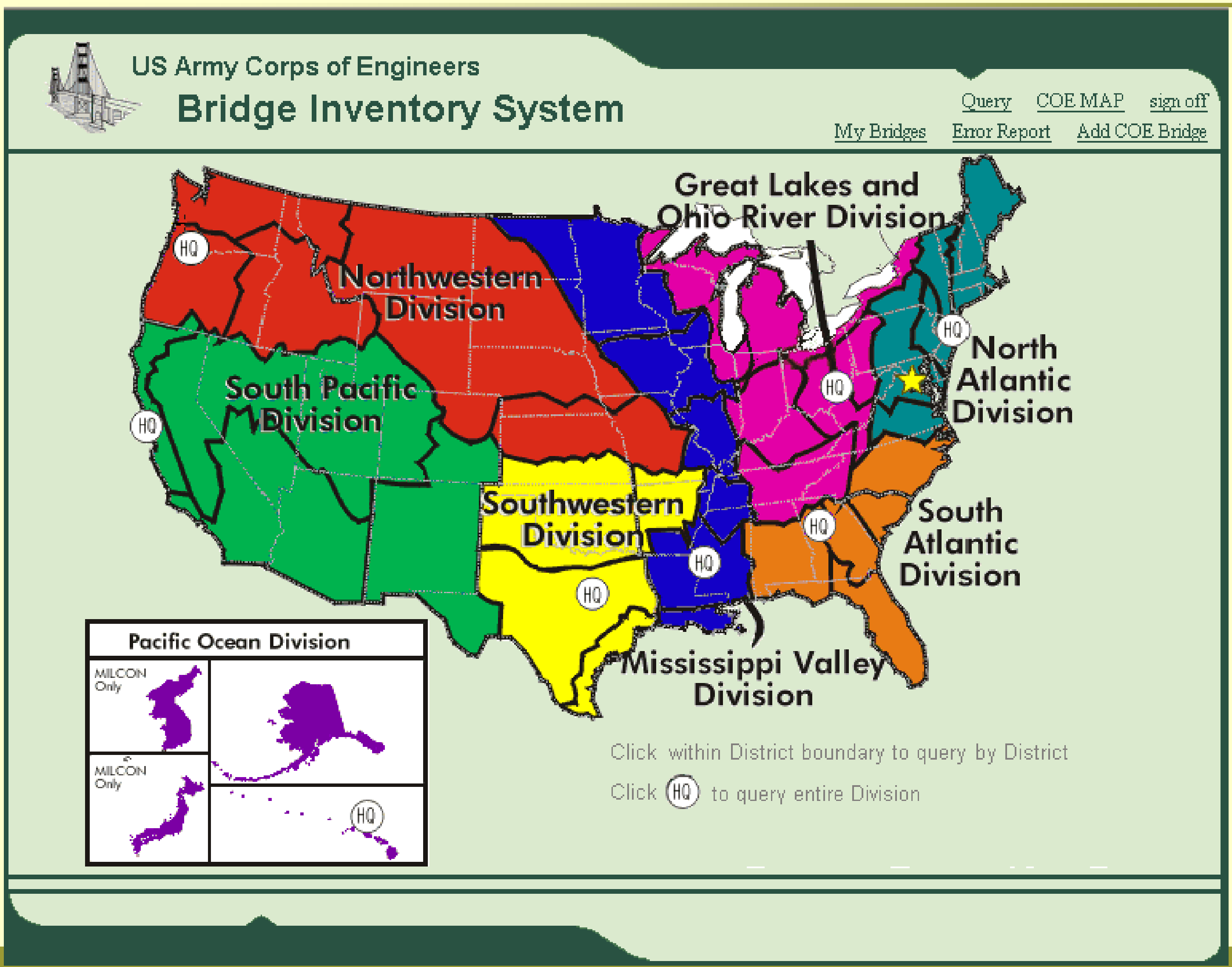

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ADD/DELETE RECORDS

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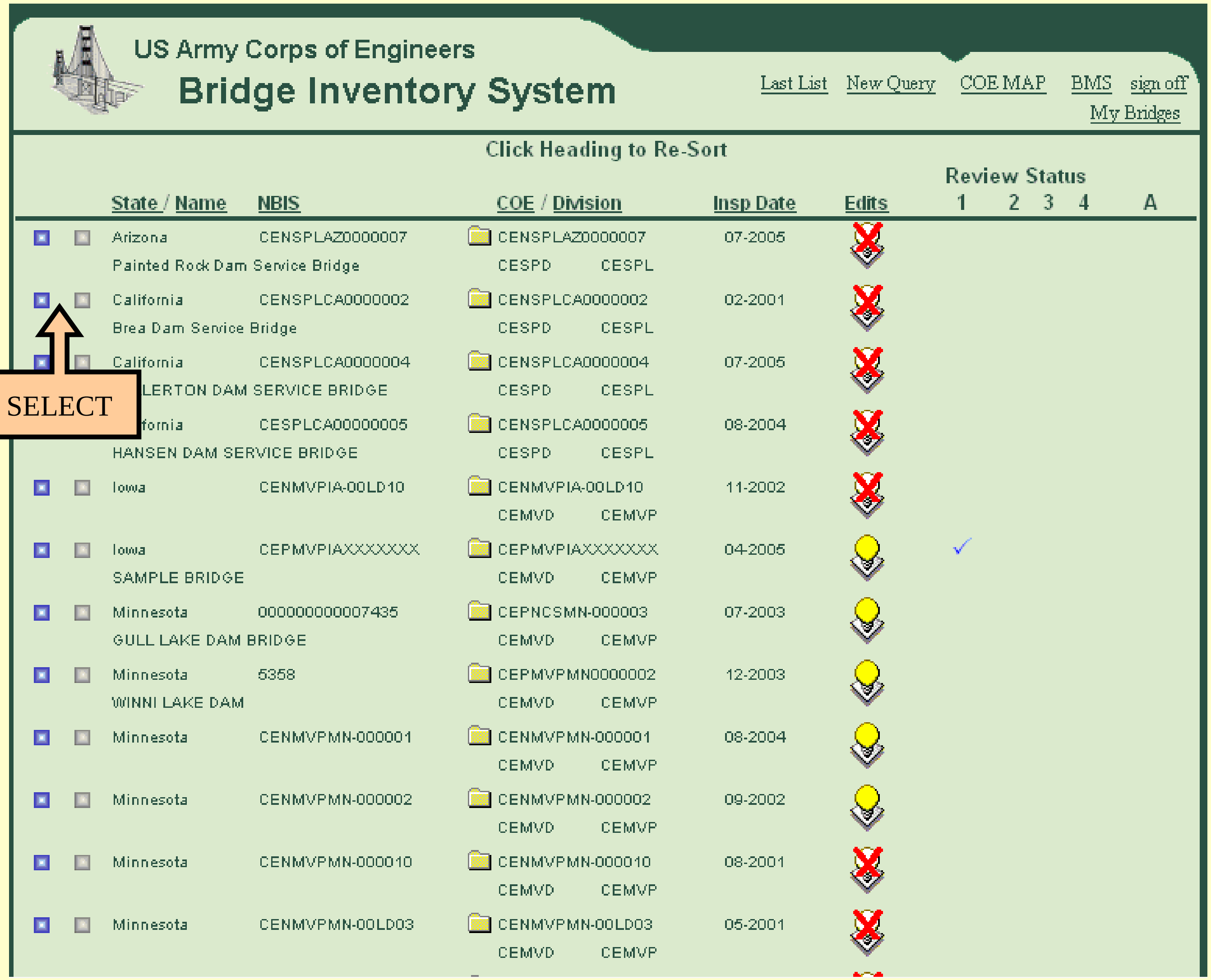

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Minnesota	CENMVPMN-000002	CENMVPMN-000002 CEMVD CEMVP	09-2002						
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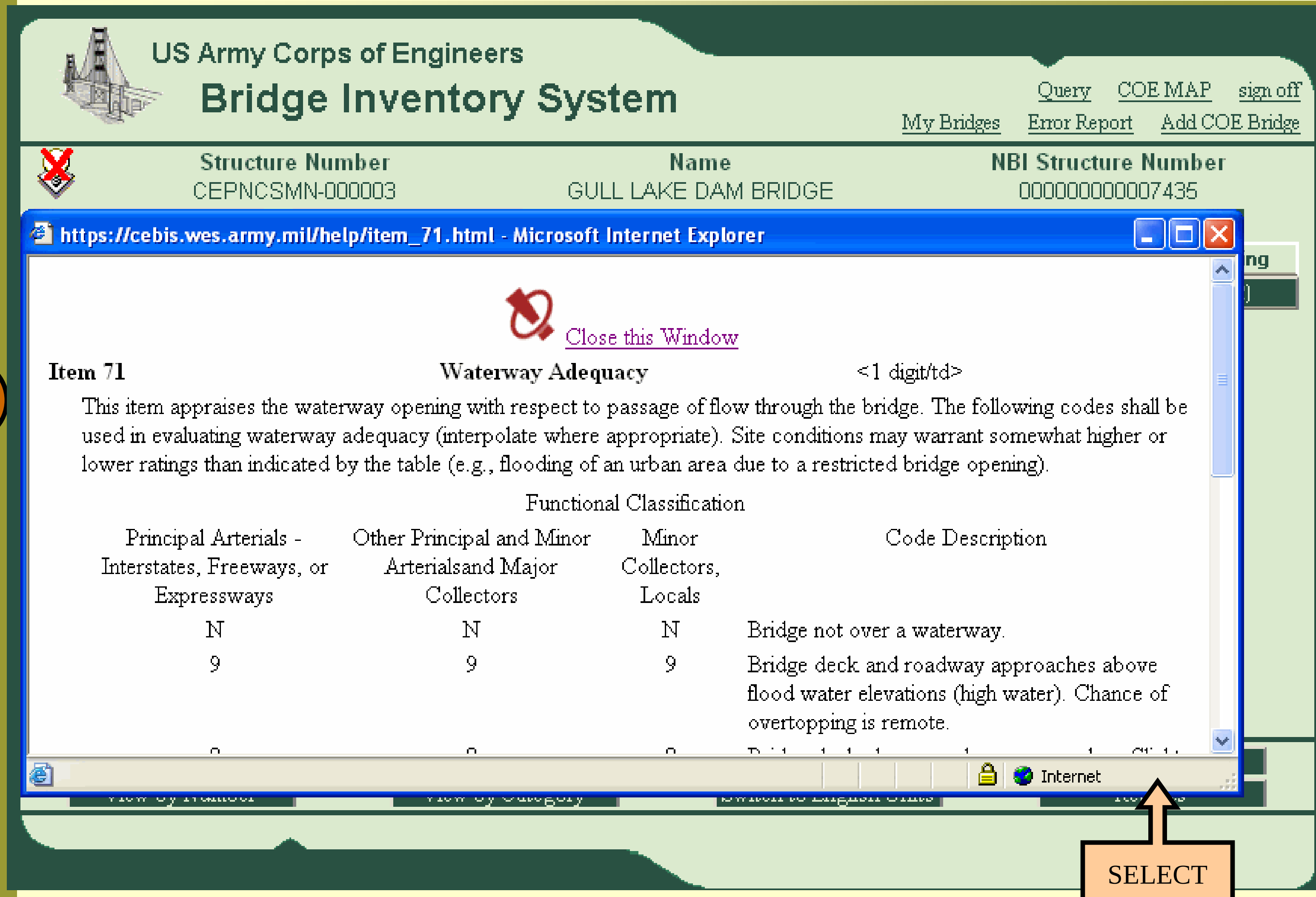

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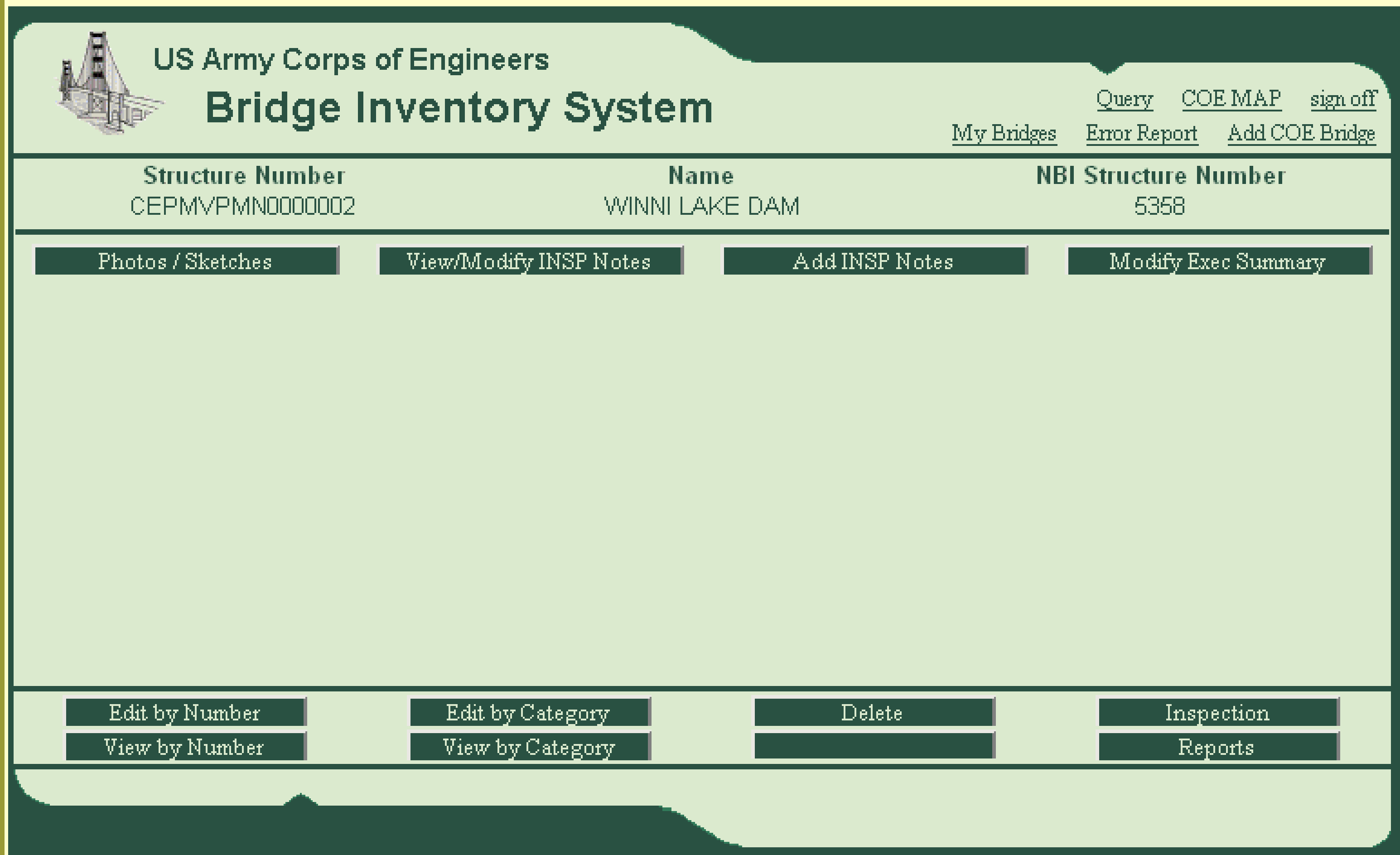

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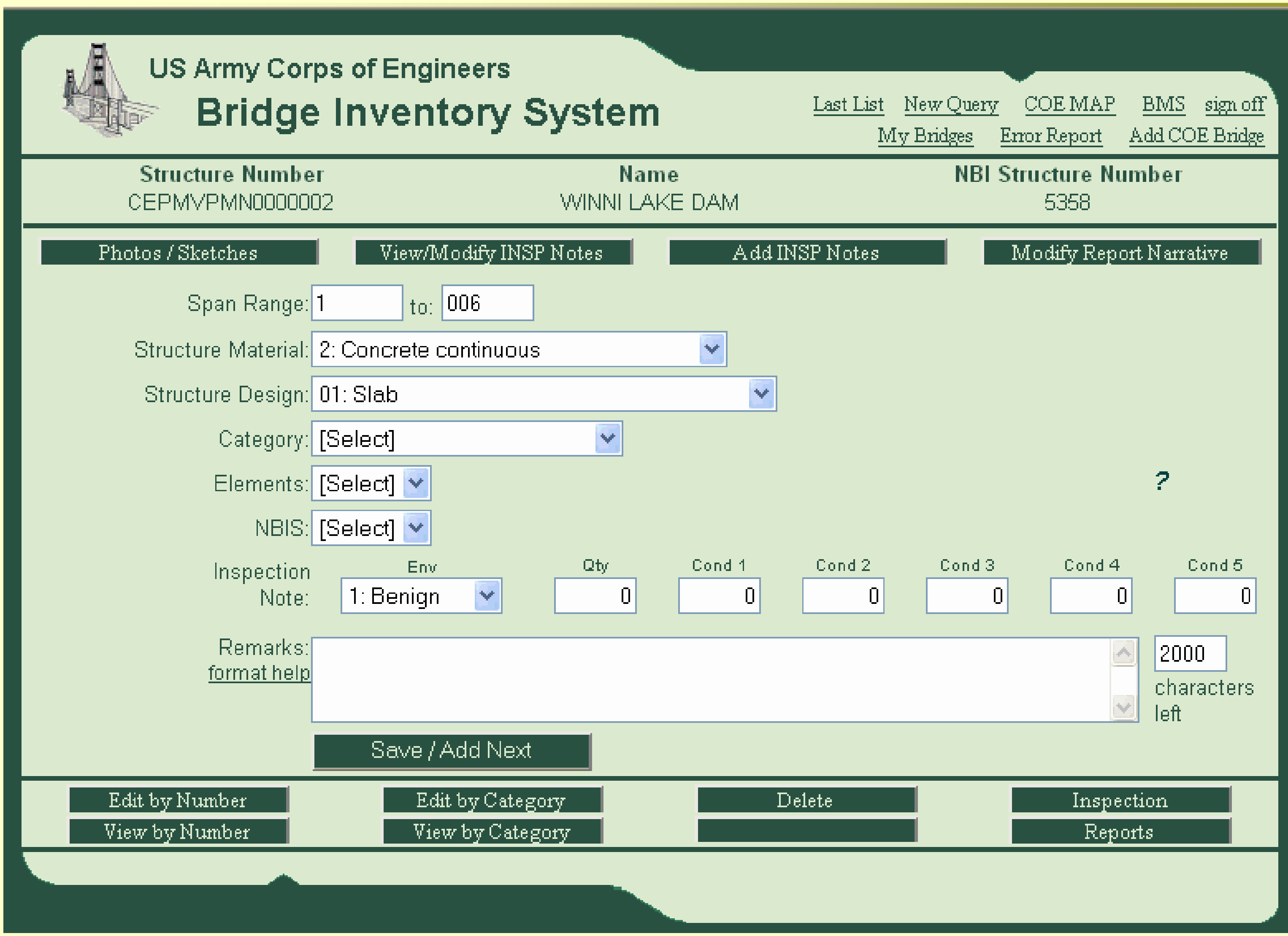

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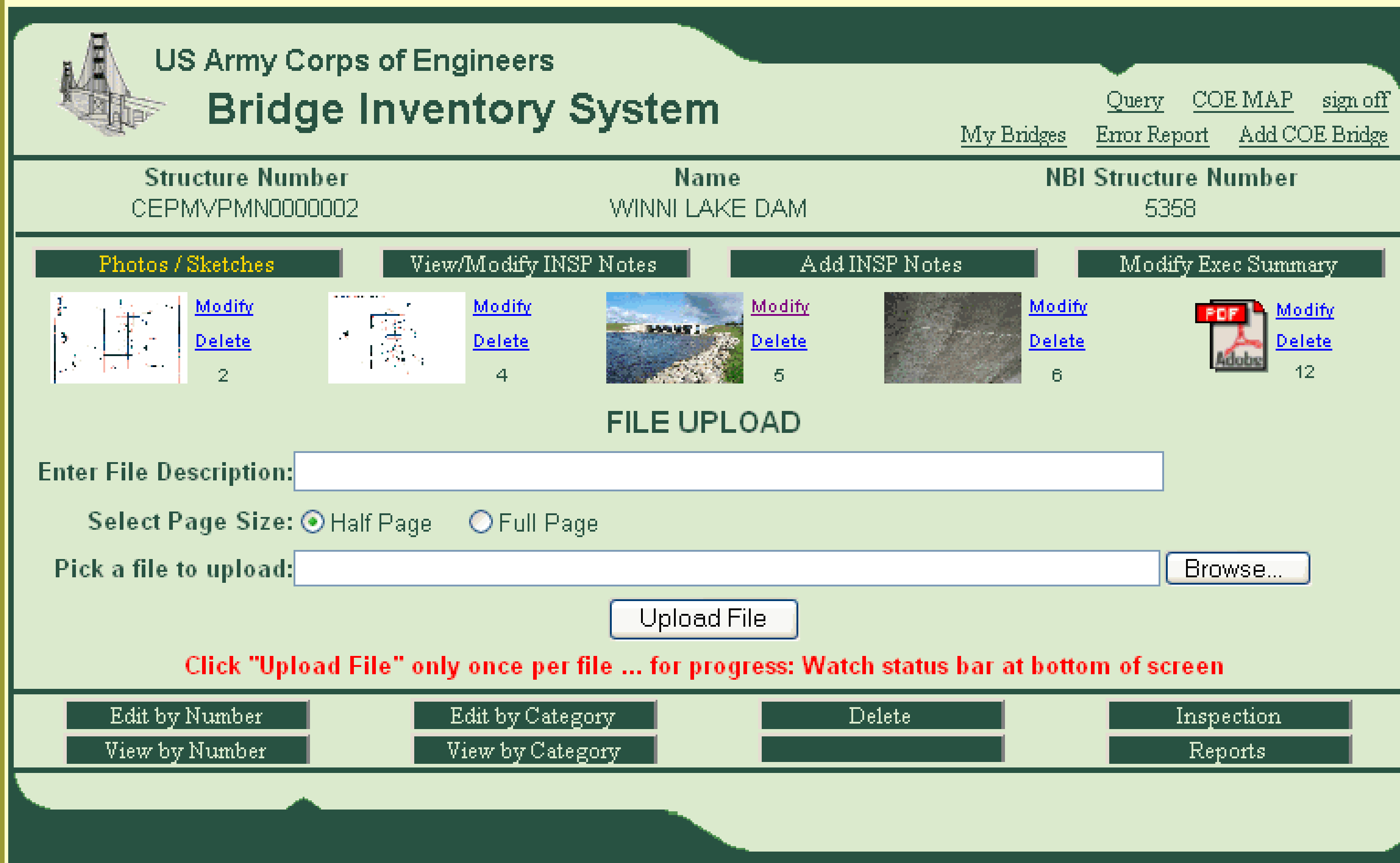

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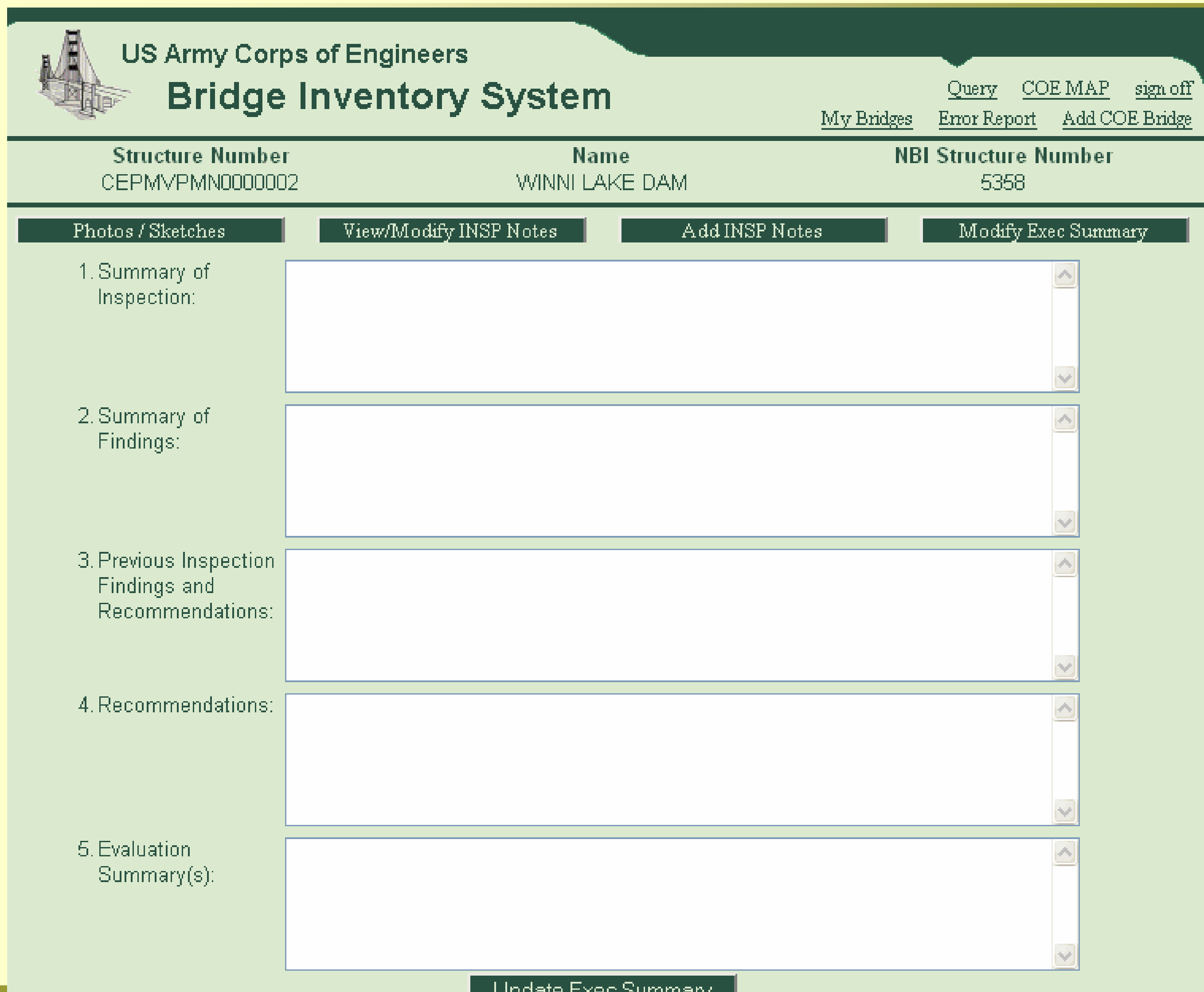

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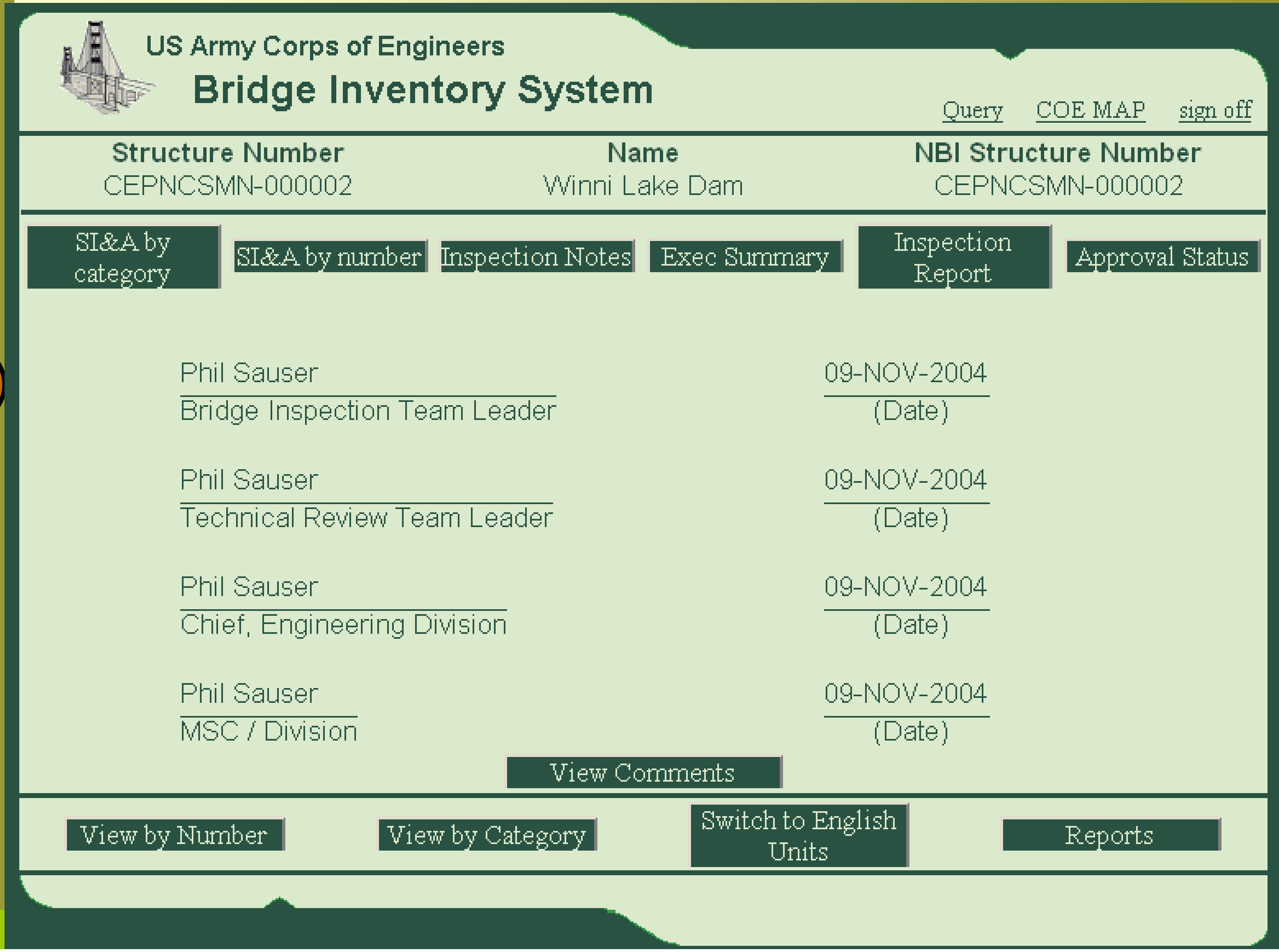

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INSPECTION REPORT

CEBIS Features

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CEBIS Features

Archival

Bridge Inspection Reporting System

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Standard Procedures for Fatigue Evaluation of Bridges

Presentation for the

2005 Tri-Service Infrastructure Conference

by

Phil Sauser

Structural Engineer, Saint Paul District

03 August 2005

Fatigue Evaluation of Bridges

Topics

- ✓ Criteria
- ✓ Background
- ✓ Design Procedures
- ✓ Inspection Procedures
- ✓ Evaluation Procedures
- ✓ Results

Fatigue Evaluation of Bridges

References

1. Manual for Condition Evaluation and Load and Resistance Factor Rating (LRFR) of Highway Bridges (The Manual)
2. AASHTO LRFD Bridge Design Specifications
3. FHWA Bridge Inspector's Reference Manual
4. NCHRP Report 299, Fatigue Evaluation Procedures for Steel Bridges
5. Fracture and Fatigue Control in Structures, Barsom & Rolfe
6. 23 CFR Part 650 National Bridge Inspection Standards (NBIS)
7. ER 1110-2-111, Periodic Safety Inspection And Continuing Evaluation Of USACE Bridges

CRITERIA

NBIS

- ✓ Inspection Procedures
- ✓ Inspection Frequencies
- ✓ Inspector Qualifications
- ✓ References The Manual

The Manual

- ✓ Inspection Procedures
- ✓ Evaluation Criteria
- ✓ References the Bridge Design Specifications

CRITERIA

Bridge Design Specifications

- ✓ Fatigue Detail Categories
- ✓ Fatigue Strengths

CORPS, ER 1110-2-111

- ✓ Update Jan. 06
- ✓ Comply w/ Revised NBIS

BACKGROUND

Evaluation Methods

- ✓ Stress Life
- ✓ Strain Life
- ✓ Fracture Mechanics

Fatigue Types

- ✓ Load Induced
- ✓ Distortion Induced

Load Cycles

- ✓ Variable Amplitude
- ✓ Constant Amplitude

EVALUATION METHODS

Stress Life

- ✓ Strengths Based on Testing
- ✓ Fatigue strengths computed for a variety of components
- ✓ Strength is in terms of allowable stress vs. load cycles

Advantages

- ✓ Simple to Use
- ✓ Better Results for Long Life (Large N) & Constant Amplitude
- ✓ Large Amount of Data Available

Disadvantages

- ✓ Empirically Based, Limited to Testing Conducted
- ✓ Plastic Strains Ignored
- ✓ No Differentiation between Crack Initiation and Propagation

EVALUATION METHODS

Strain Life

- ✓ Strengths Based on Testing
- ✓ Fatigue strengths computed for a variety of components
- ✓ Accounts for Stress-Strain Response of Material

Advantages

- ✓ Accounts for Plastic Strain, Residual Stress
- ✓ Considers Cumulative Damage under Variable Amplitude
- ✓ Results can be Extrapolated to Complicated Geometries

Disadvantages

- ✓ More complicated (Numerical Integration Techniques)
- ✓ Accounts Only for Initiation Life

EVALUATION METHODS

Fracture Mechanics

- ✓ More Theory Oriented

Advantages

- ✓ Predicts Crack Growth, Failure
- ✓ Allows Monitoring of Cracks
- ✓ Gives Better Insight Into Behavior

Disadvantages

- ✓ Crack Size Must Be Known
- ✓ More Complex Analyses Required

BACKGROUND

FATIGUE TYPES

Load Induced

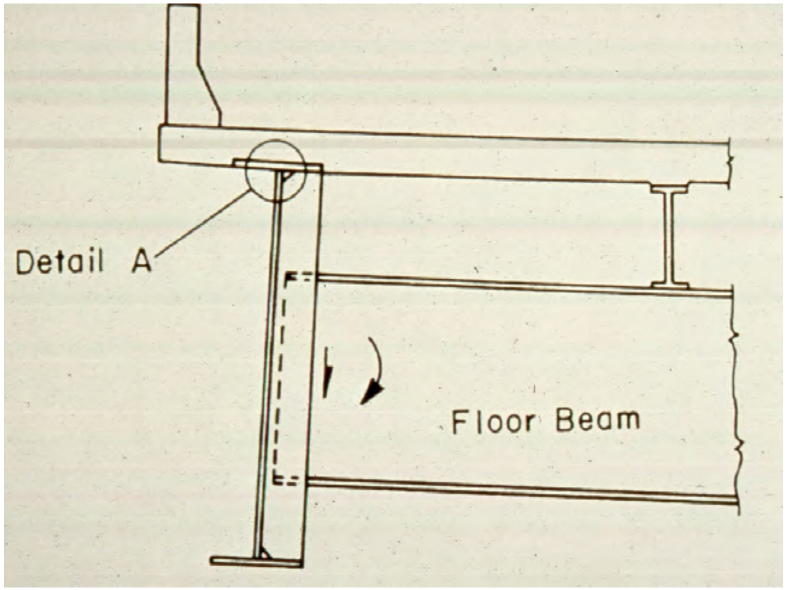
- ✓ In Plane Stresses
- ✓ Accounted For In Design
- ✓ Detail Sensitive

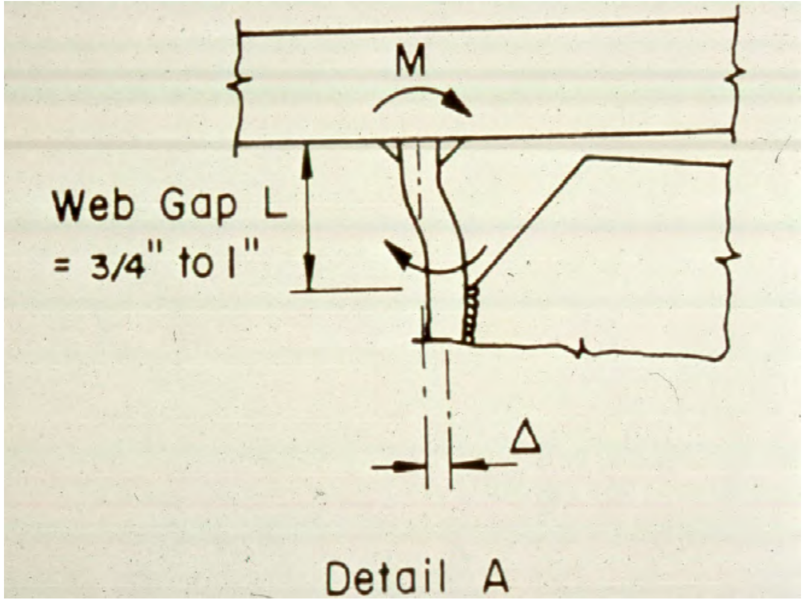
Distortion Induced

- ✓ Secondary Stresses
- ✓ Not Accounted For In Design
- ✓ Detail Sensitive

FATIGUE TYPES

Distortion Induced Examples





LOADING TYPES

LOADING TYPES

Constant Amplitude

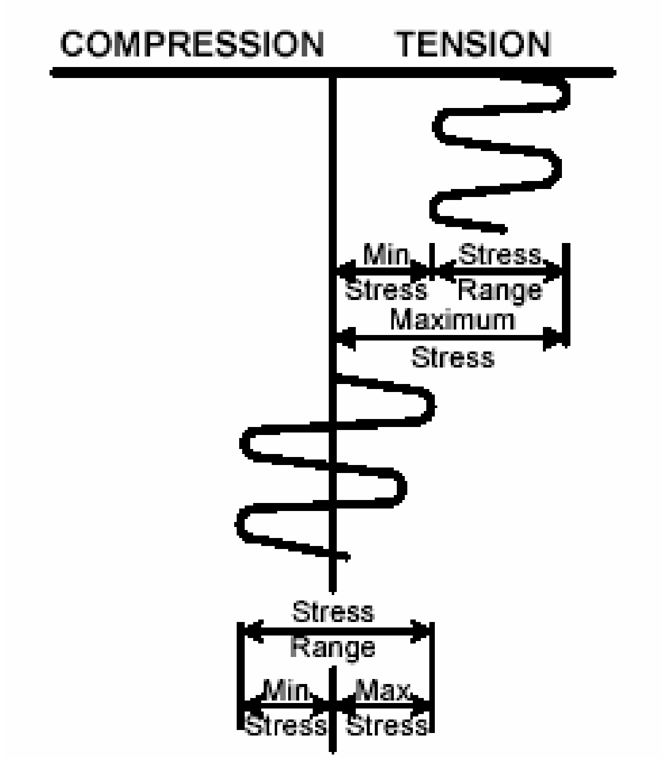
- ✓ Stress Range Does Not Vary
- ✓ Test Applications

Variable Amplitude

- ✓ Random Sequence of Load History
- ✓ Realistic Behavior

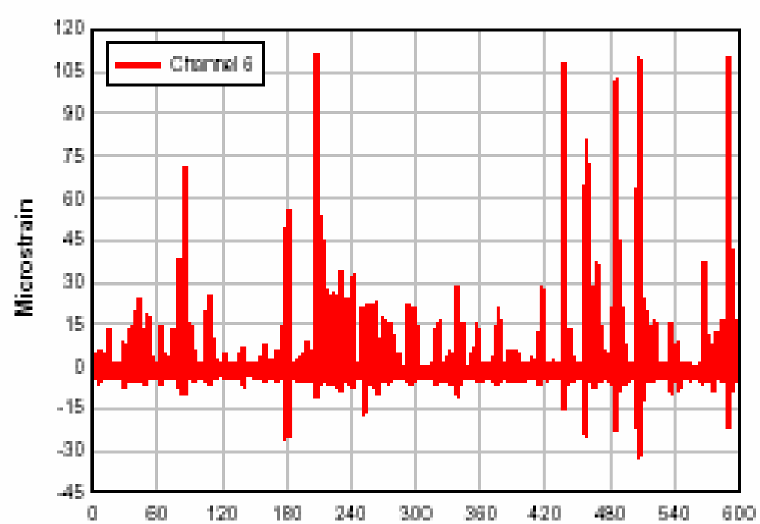
LOADING TYPES

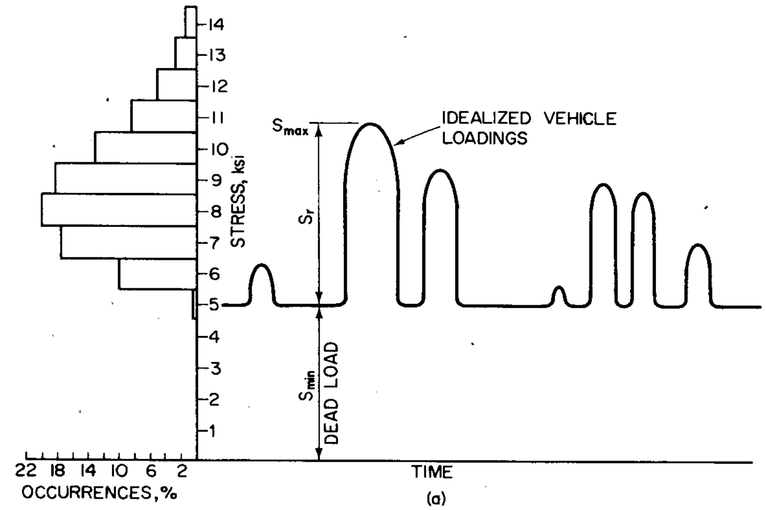
Constant Amplitude

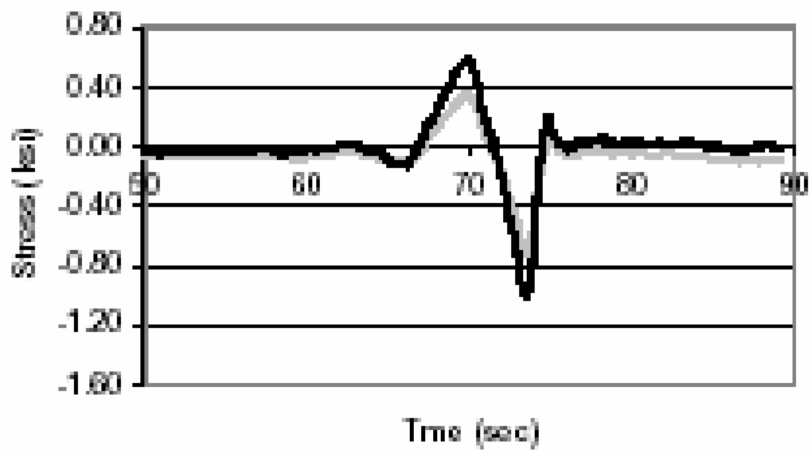


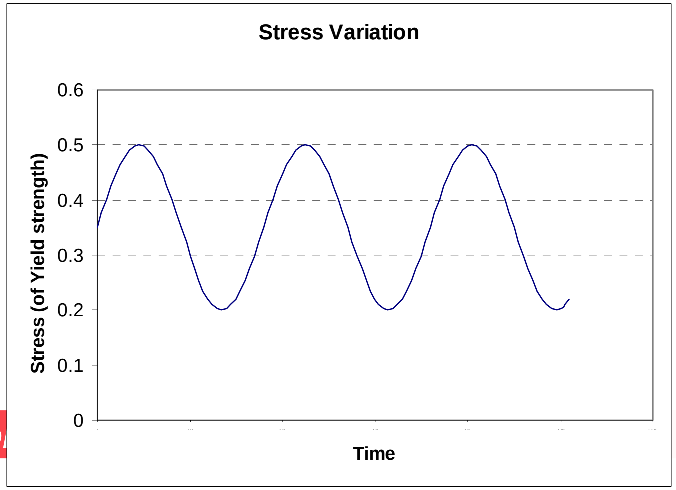
LOADING TYPES

Variable Amplitude









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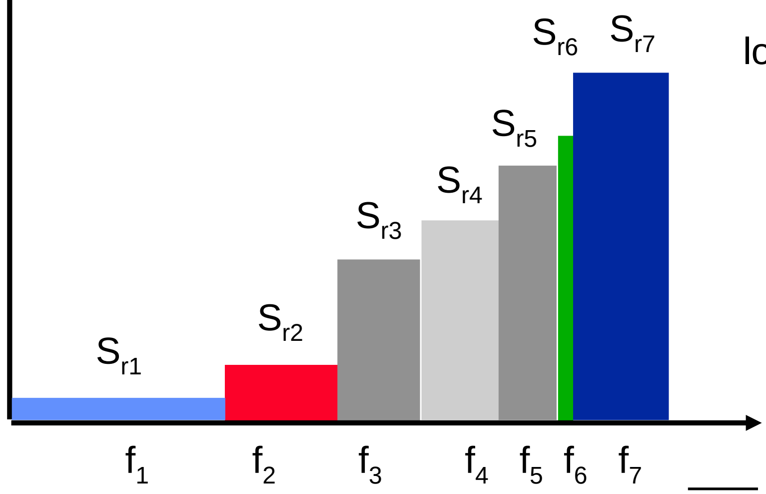
Variable Amplitude

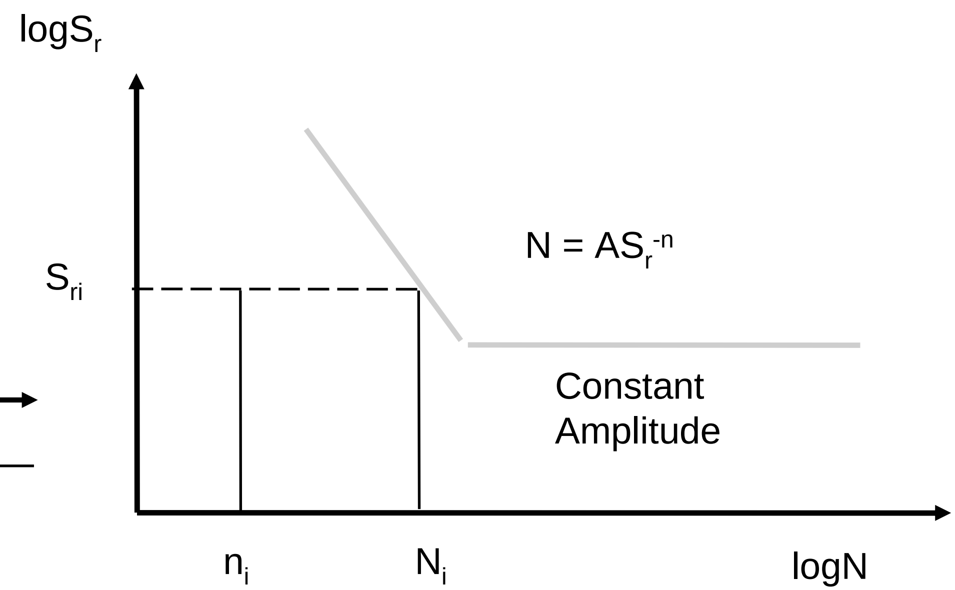
Conversion to Constant Amplitude

- ✓ Compute Effective Stress
  - ✓ Equivalent constant amplitude stress range that produces the same fatigue damage as a variable amplitude spectrum
  - ✓ Effective stress range based on fatigue tests under simulated traffic
- ✓ Miner's Law
  - ✓ The fatigue damage caused by a given number of cycles of effective stress range (constant amplitude cycles) is the same damage caused by an equal number of variable stress ranges (variable amplitude).
  - ✓ Root Mean Cube (Log S vs. Log N fatigue curve)

Variable Amplitude Conversion



I	n_i	S_{ri}	f_i	$f_i S_{ri}^3$
1	4,500,000	0.1	0.792	0.001
2	800,000	0.6	0.141	0.030
3	140,000	5.6	0.025	4.390
4	232,000	7.8	0.041	19.457
5	3,900	10.2	0.0007	0.743
6	113	14.0	0.00002	0.055
7	2,300	15.0	0.0004	1.350
	N_T= 5,678,313		1.0	26.026



$$S_{re} = \sqrt[3]{26.026} = 2.963..ksi$$

BACKGROUND

AASHTO METHOD

Load Induced Fatigue

- ✓ Uncracked, Unrepaired Members
- ✓ Does not consider distortion, corrosion, or other damage

Stress Life Approach

- ✓ S-N Curves
- ✓ Constant Amplitude Stress Ranges

Reliability Based Philosophy

- ✓ Statistics
- ✓ Data
- ✓ Variables

AASHTO METHOD

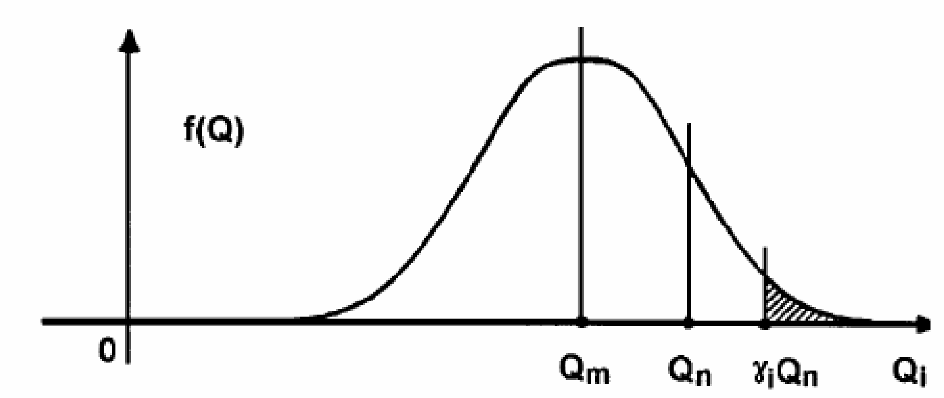
RELIABILITY

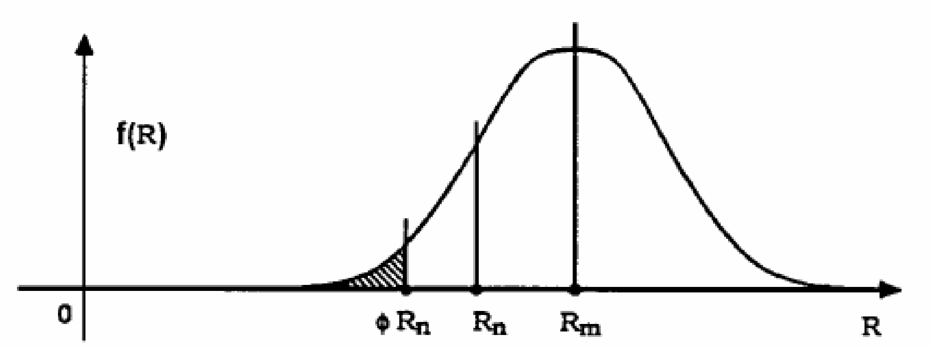
Random Variables

- ✓ Stress
  - ✓ Loads (truck weights, axle configurations, weight distribution, impact, multiple presence)
  - ✓ Load Distribution (analysis methods & assumptions, bridge behavior)
  - ✓ Section Properties
- ✓ Load Cycles
  - ✓ Traffic Volume
  - ✓ Stress Cycles
- ✓ Fatigue Strengths
  - ✓ Details (Real vs. Modeled)
  - ✓ Tests (Real vs. Laboratory)

AASHTO METHOD

TARGET RELIABILITY



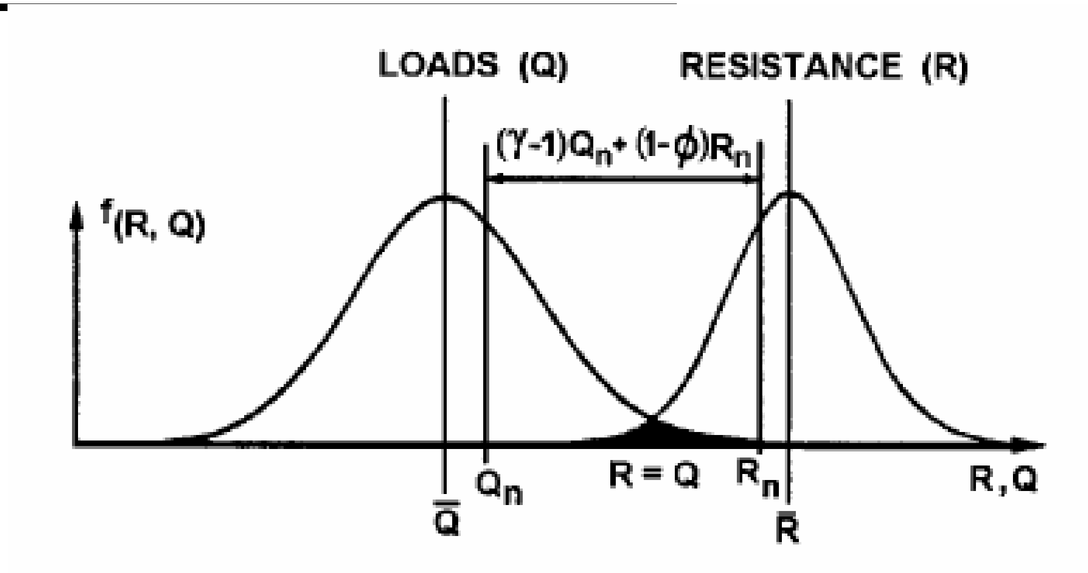


Loads **Resistance**

Probability Density Function

AASHTO METHOD

TARGET RELIABILITY



Loads Vs. Resistance

<u>Probability Density Function</u>

AASHTO METHOD

TRAFFIC LOADING

Fatigue Truck

- ✓ HS20 Truck with Constant 30’ Spacing of Rear Axles
  - ✓ 0.75 Load Factor (54 kip)
  - ✓ Single Truck
  - ✓ Single Lane
  - ✓ Represent Typical Traffic

- ✓ WIM Studies
  - ✓ Effective Weight Calculated (Miner’s Rule)
  - ✓ Used to Compute Constant Amplitude Loading Cycles

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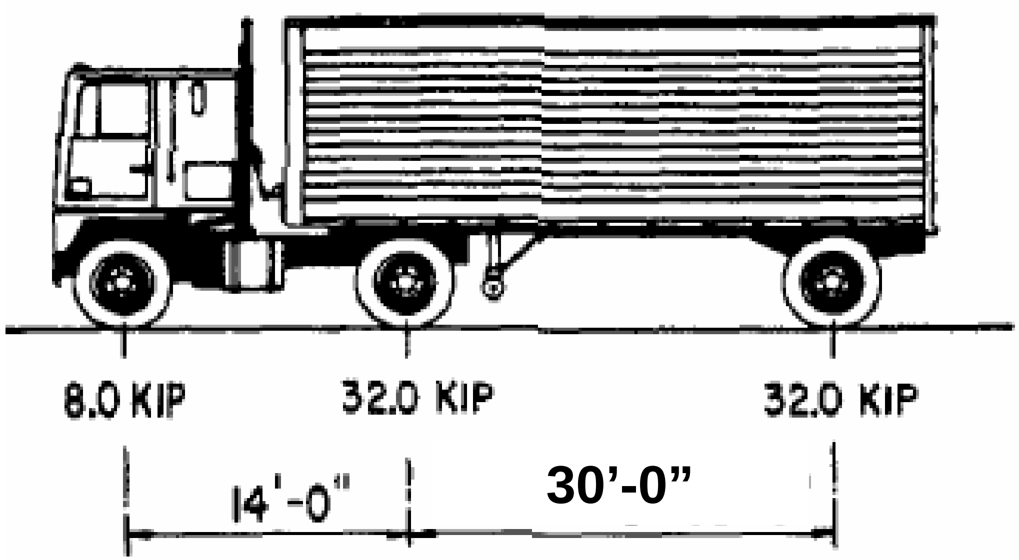
AASHTO METHOD

Fatigue Truck



AASHTO METHOD

FATIGUE STRENGTHS

S-N Curves

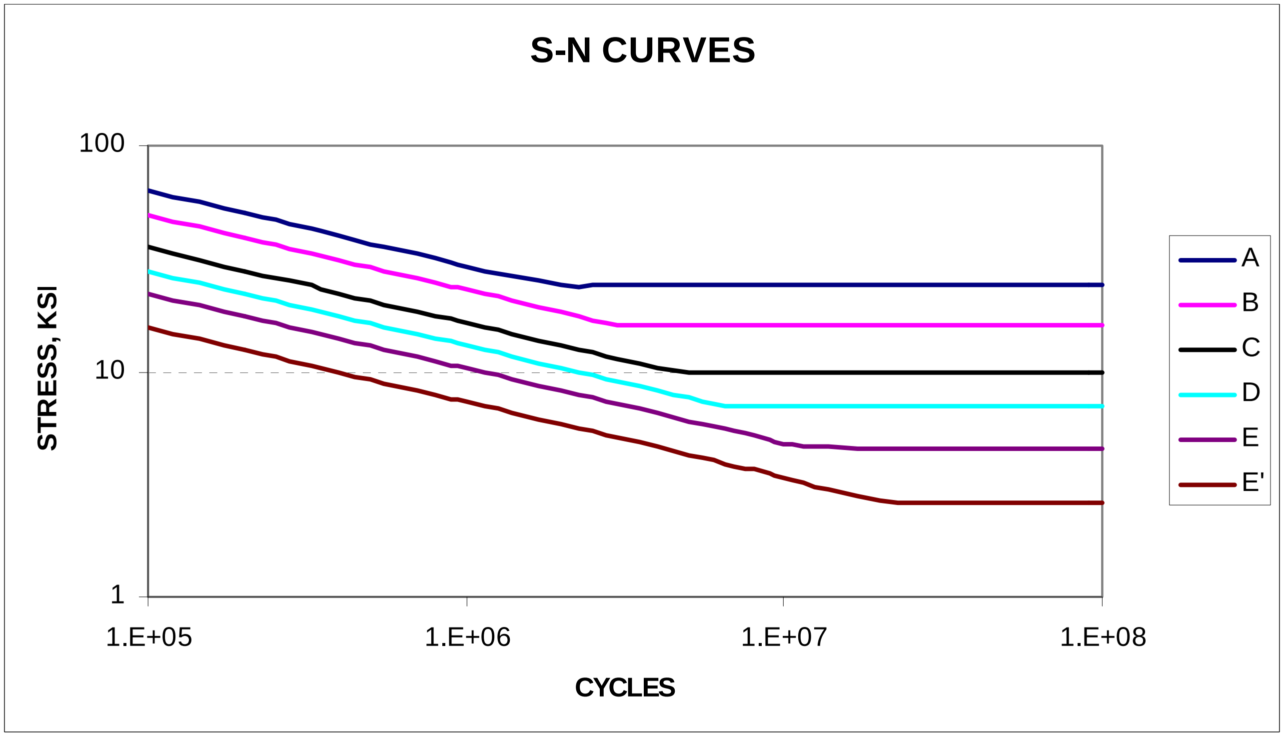
- ✓ Test identical details at different effective stress ranges
- ✓ Typical Relationship for Steel: $S_r = AN^b$
- ✓ b = -1/3
- ✓ Log-Log Plot
- ✓ Threshold Limit

Stress Limit Influences

- ✓ Stress Concentrations
- ✓ Residual Stress

AASHTO METHOD

S-N Curves



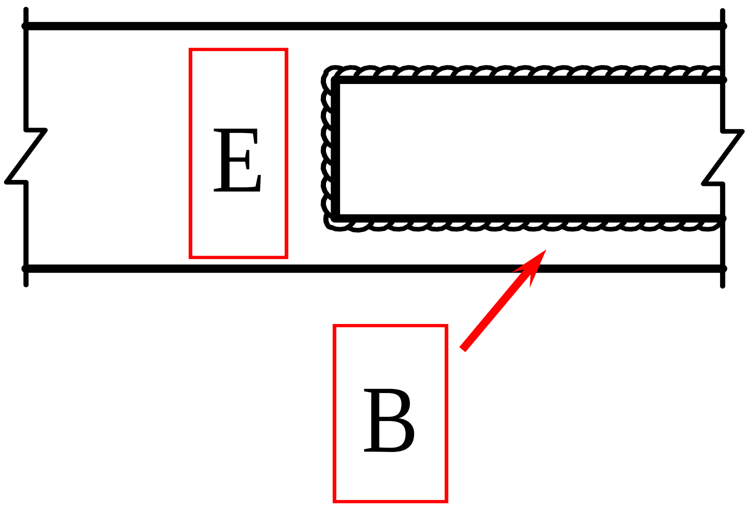
AASHTO METHOD

FATIGUE STRENGTHS

Fatigue Detail Categories

- ✓ 8 Categories (A-E')
- ✓ 11 General Conditions (Table 6.6.1.2.3-1)
  - ✓ Plain Members
  - ✓ Built-Up Members
  - ✓ Groove Welded Members
  - ✓ Fillet Welded Members

Fatigue Details



Builtup Member

B - Continuous fillet weld parallel to direction of applied stress

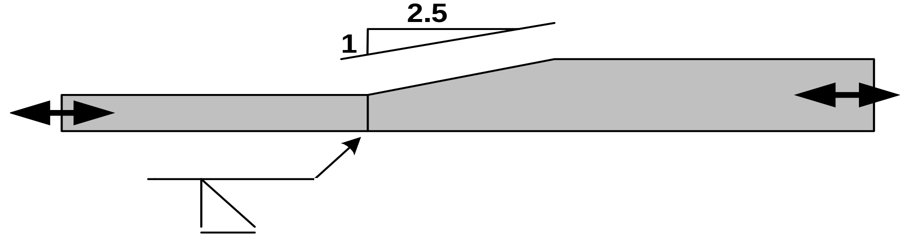
E – Base metal at ends of partial-length cover plates, narrower than flange, fl. Thickness < 0.8”

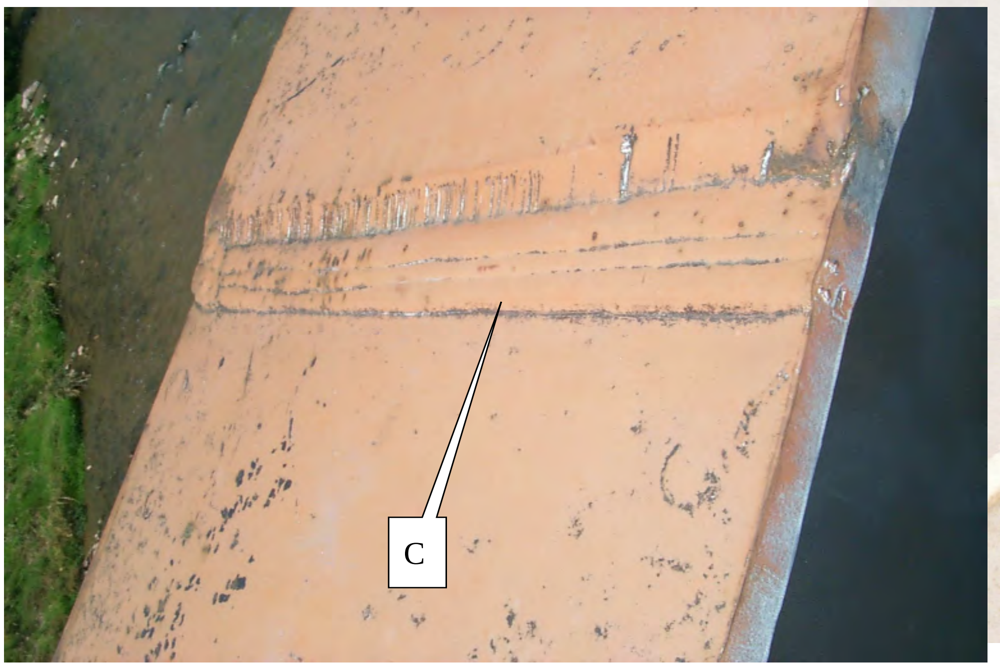
Fatigue Details

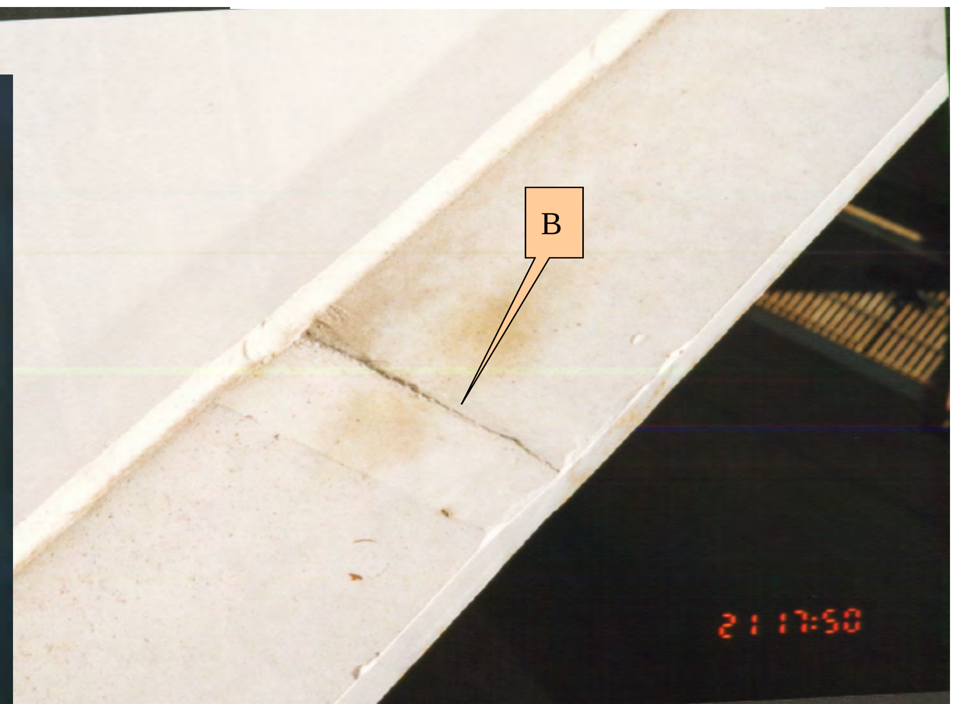
Groove Welded Splice (NDT)

B – Thickness transition 1:2.5 or shallower

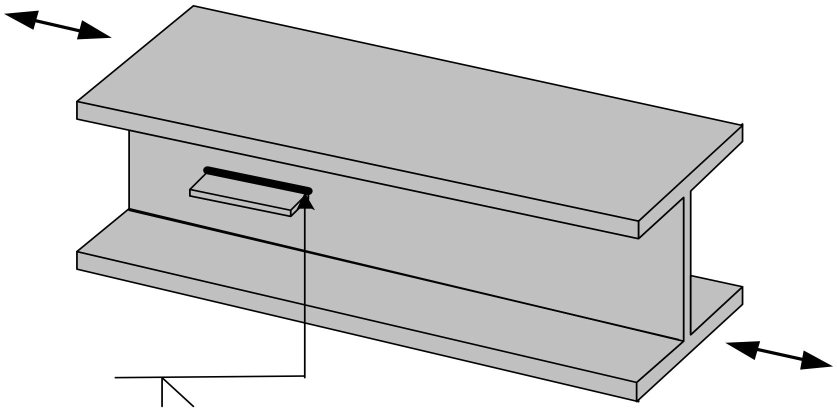
C – Weld Reinforcement not removed.

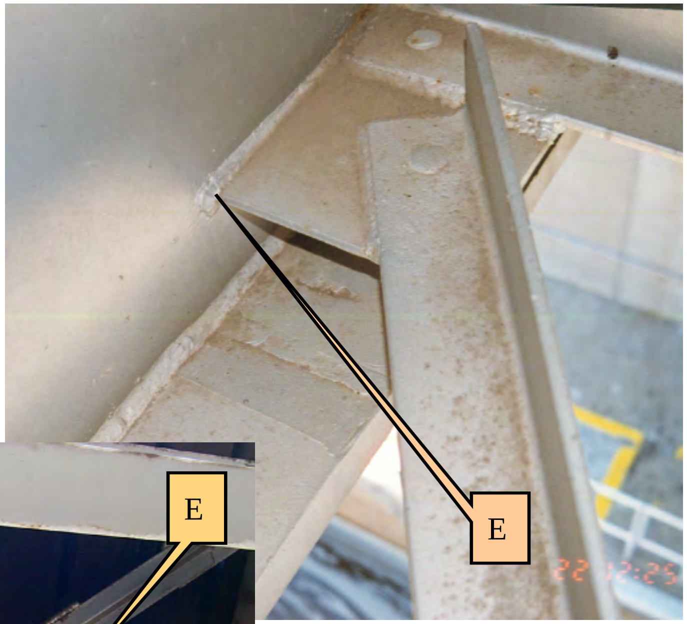






Fatigue Details



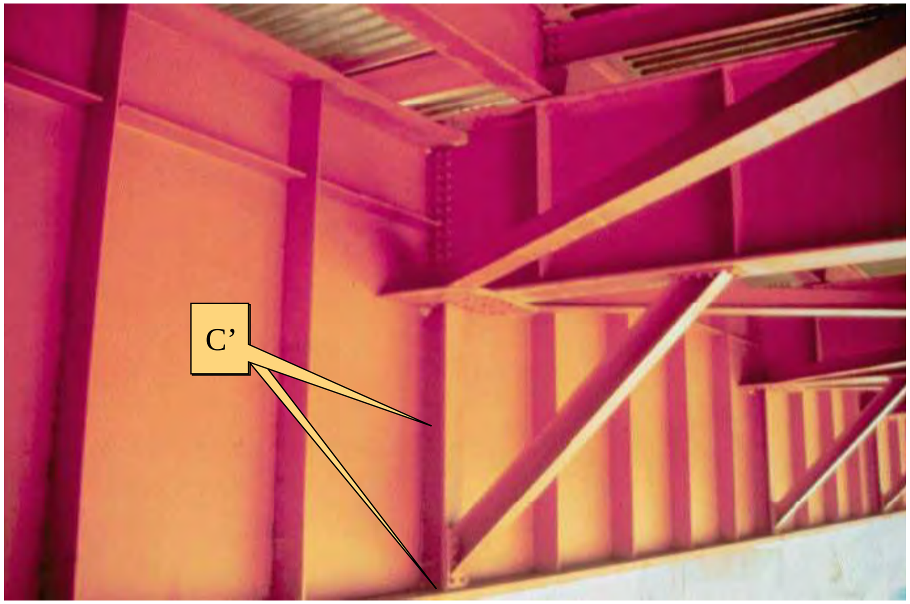


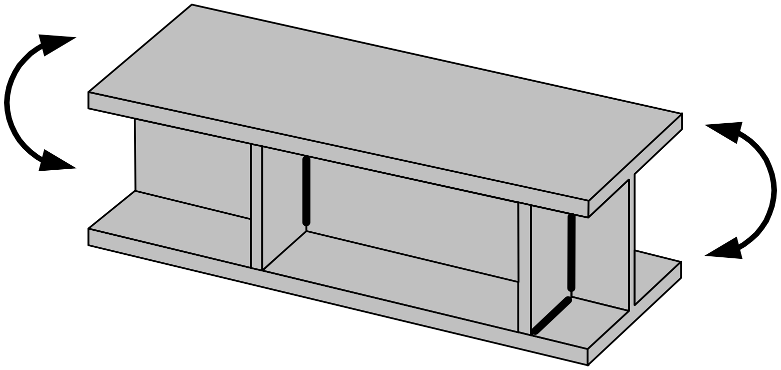
Longitudinally Loaded Fillet Welds

E – Detail Length > 12t or 4”

E –No transition radius

Fatigue Details



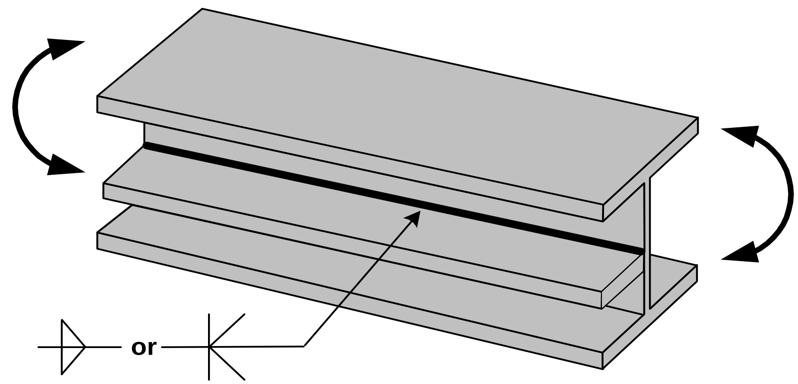


Category C’

Fillet Weld Connections, Welds Normal to Direction of Stress

C’ – At toe of stiffener to flange or stiffener to web

Fatigue Details



Builtup Member

B - Continuous welds parallel to direction of applied stress

Category B

Fatigue Details

Mechanical Connections

B – Bolted

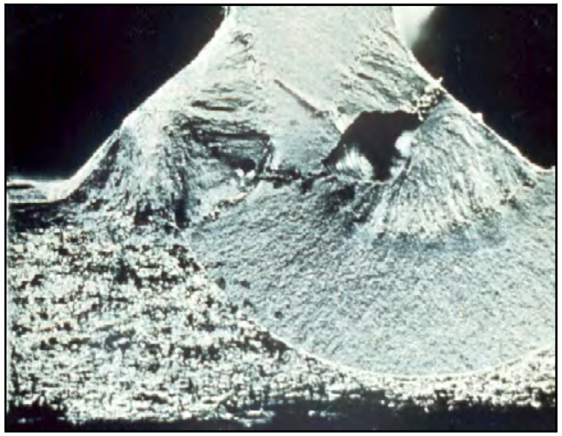
D – Riveted

Category B

Category D

Fatigue Details

Category N (Not Allowed)

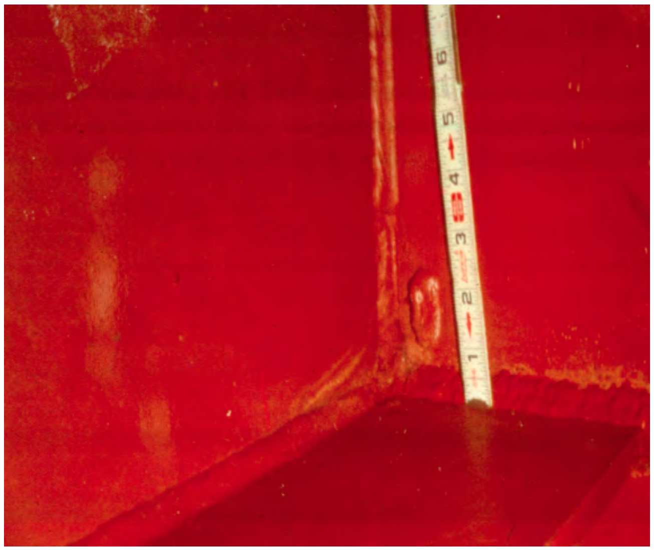


Noncompliant Weld

Cracked Weld

Fatigue Details

Category N (Not Allowed)

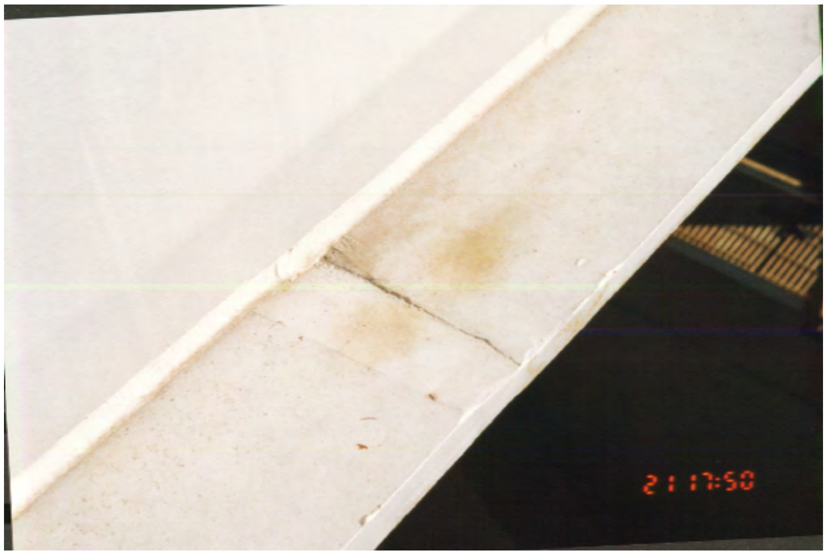


Triaxial Constraints

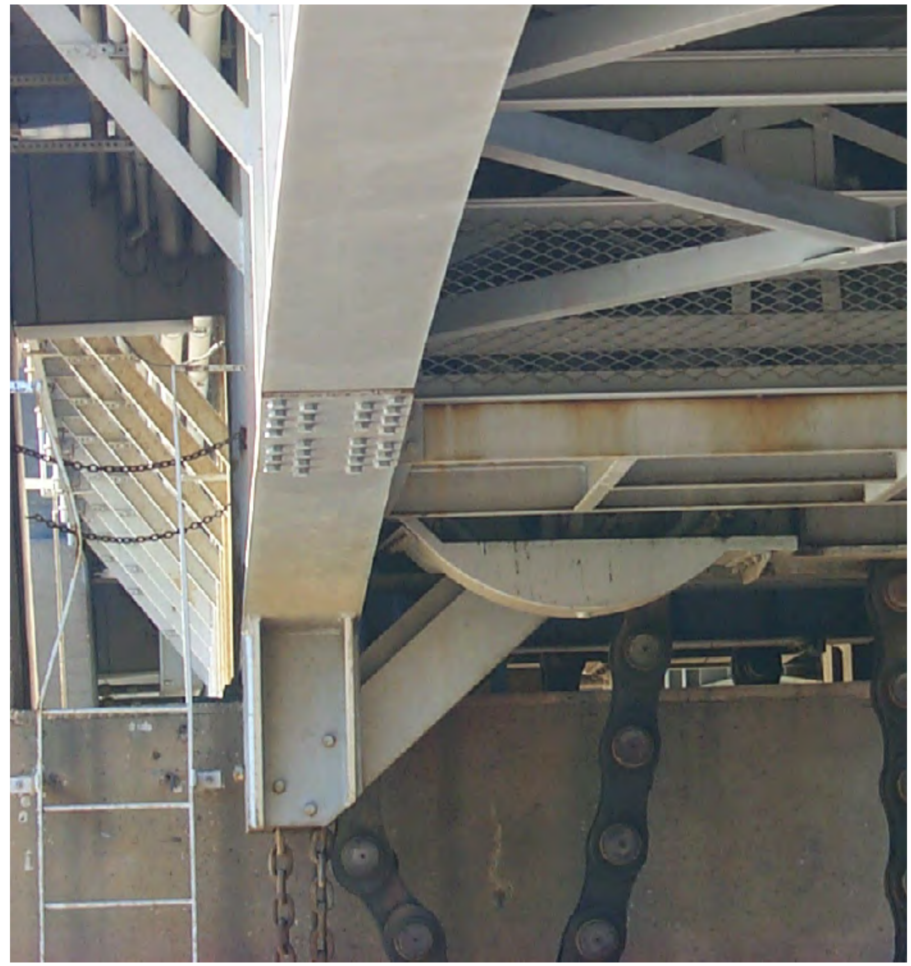
Excessive Corrosion

Fatigue Details

Category N (Not Allowed)



Transversely Loaded Partial Penetration Groove Welds



DESIGN PROCEDURES

Design Equation $\lambda(\Delta f) \leq \varphi(\Delta F)_n$ $\lambda = 0.75$ $\varphi = 1.0$

(Δf) = Live Load Stress Range

$(\Delta F)_n$ = Nominal Fatigue Resistance

Design Procedures

1. Identify Fatigue Detail Category (C-E')
2. Apply Load – Single Truck, Single Lane, Max Effect
3. Distribute Load – Single Lane Load Distribution Factors
4. Apply Impact Factor (1.15)
5. Compute Section Properties – Short-Term Composite
6. Compute Stress at Detail – M/S, P/A
7. Compute Constant Amplitude Cycles – 75 year life
    - $N=365(75)n(ADTT)_{SL}$
8. Compute Nominal Strength (Fatigue Resistance)

DESIGN PROCEDURES

7. $N=365(75)n(ADTT)_{SL}$

- N = No. of Stress Range Cycles per Truck

Table 6.6.1.2.5-2 Cycles per Truck Passage, n		
Longitudinal Members	> 40.0 ft.	< 40.0 ft.
Simple Span Girders	1.0	2.0
Continuous Girders		
1) near interior support	1.5	2.0
2) elswhere	1.0	2.0
Cantilever Girders	5.0	
Trusses	1.0	
Transverse Members	Spacing	
	> 20.0 ft.	< 20.0 ft.
	1.0	2.0

DESIGN PROCEDURES

7. $N=365(75)n(ADTT)_{SL}$

- $(ADTT)_{SL} = p \cdot ADTT$

Table 3.6.1.4.2-1 Fraction of Truck Traffic in a Sinple lane, p	
Number of Lanes Available to Trucks	p
1	1.00
2	0.85
3	0.80
>3	0.80

Table C3.6.1.4.2-1 ADTT	
Class of Highway	ADTT
Rural Interstate	0.20
Urban Interstate	0.15
Other Rural	0.15
Other Urban	0.10

DESIGN PROCEDURES

Design Procedures

8. Compute Nominal Strength (Fatigue Resistance)

$(\Delta F)_{TH}$ = Constant Amplitude Fatigue Threshold

$$(\Delta F)_n = \left(\frac{A}{N}\right)^{\frac{1}{3}} \geq \frac{1}{2}(\Delta F)_{TH}$$

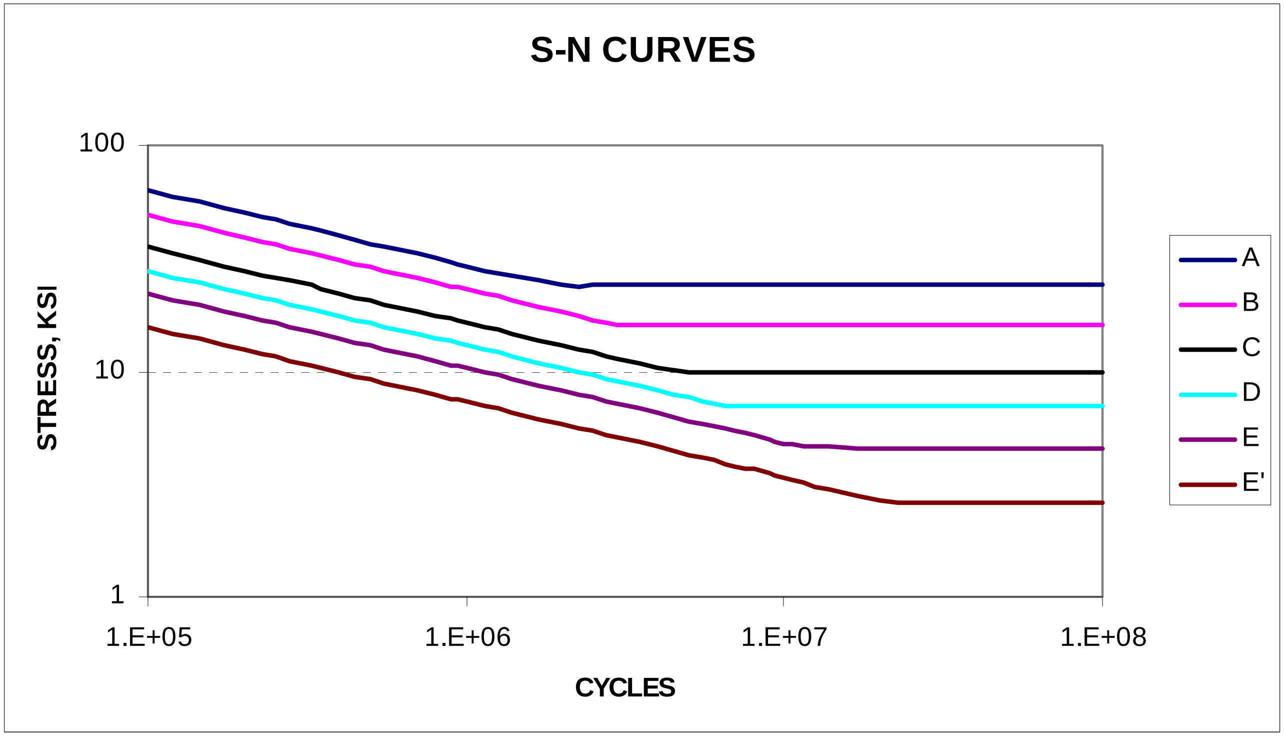
Table 6.6.1.2.5-1
Detail Category Constant, A

DETAIL CATEGORY	A (10^8 ksi)
A	250.0
B	120.0
B'	61.0
C	44.0
C'	44.0
D	22.0
E	11.0
E"	3.9

Table 6.6.1.2.5-3
Constant-Amplitude Fatigue Thresholds

DETAIL CATEGORY	Threshold (ksi)
A	24.0
B	16.0
B'	12.0
C	10.0
C'	12.0
D	7.0
E	4.5
E"	2.6

DESIGN PROCEDURES

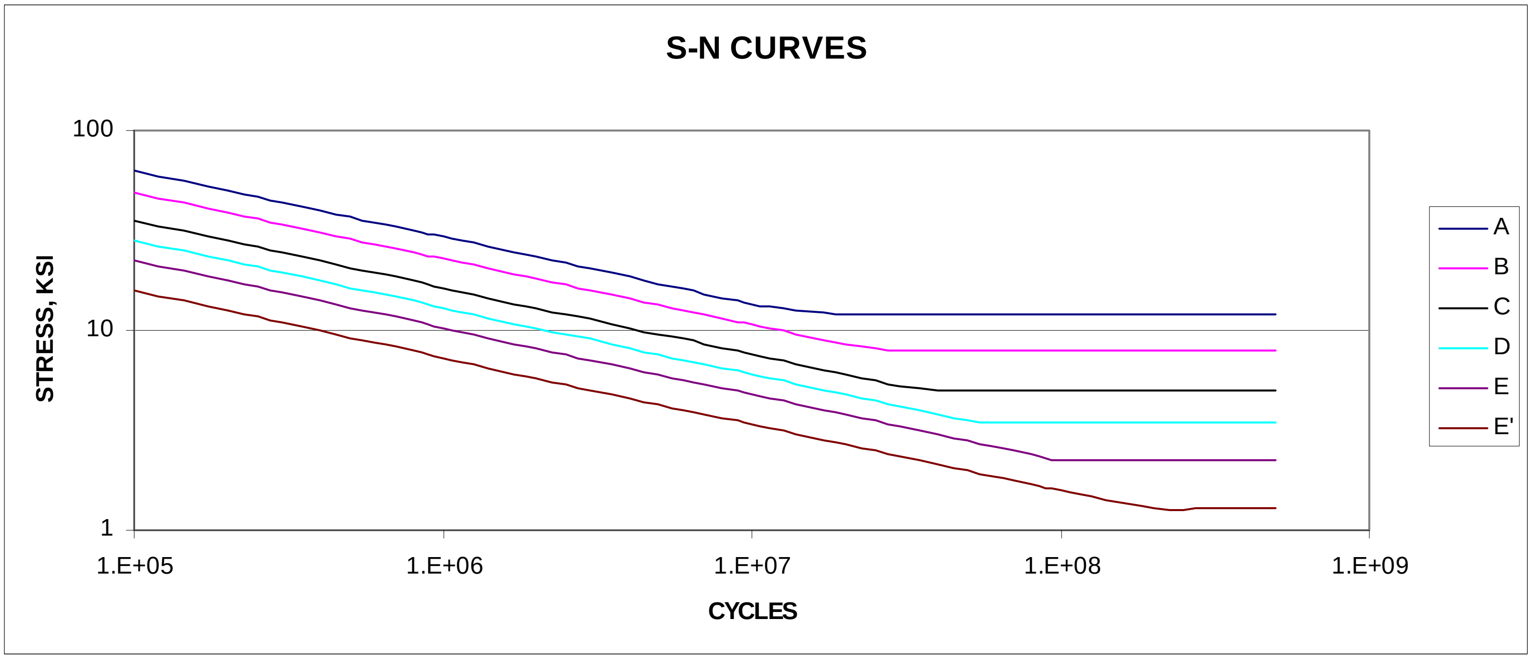


DESIGN PROCEDURES

$$\frac{1}{2}(\Delta F)_{TH}$$

- ✓ Assures the maximum applied stress range will always be less than the constant-amplitude fatigue threshold.
- ✓ This provides a theoretically infinite fatigue threshold.
- ✓ The maximum applied stress range is assumed to be twice that computed from a passage of the fatigue truck.

DESIGN PROCEDURES



DESIGN PROCEDURES

Other Considerations

- ✓ Transversely Loaded Fillet Welds
  - ✓ See Additional Equation
- ✓ Members Under Dead Load Compression
  - ✓ Consider if Fatigue LL Tensile Stress > ½ DL Compressive Stress

INSPECTION PROCEDURES

Preparation

- ✓ Review As-Builts
- ✓ Identify Fatigue Details
- ✓ Identify FCMs
- ✓ Provide Proper Access

Inspection/Documentation

- ✓ Locate fatigue sensitive details and Identify category
- ✓ ***Inspect for cracks or signs of cracks***
- ✓ ***Inspect for noncompliant weld quality***
- ✓ ***Inspect for excessive corrosion***
- ✓ ***Inspect for other discontinuities (copes, nicks, gouges. Etc.)***
- ✓ ***Identify Intersecting welds***
- ✓ ***Identify Details (distortion, end restraints)***
- ✓ ***Emphasis on FCMs (NDT)***

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INSPECTION PROCEDURES

End Restraint

EVALUATION PROCEDURES

Two Levels of Evaluation

- ✓ Infinite Life
- ✓ Finite Life

Fatigue Life Determinations

- ✓ Design Life
- ✓ Evaluation Life
- ✓ Mean Life

EVALUATION PROCEDURES

Stress Ranges

- ✓ AASHTO Fatigue Truck
- ✓ Truck Traffic Surveys
- ✓ Measured Effective Stresses

EVALUATION PROCEDURES

Truck Traffic Surveys

- ✓ Weigh Stations
- ✓ Weigh In Motion (WIM) Studies

$$W = 500(\frac{LN}{N-1} + 12N + 36)$$

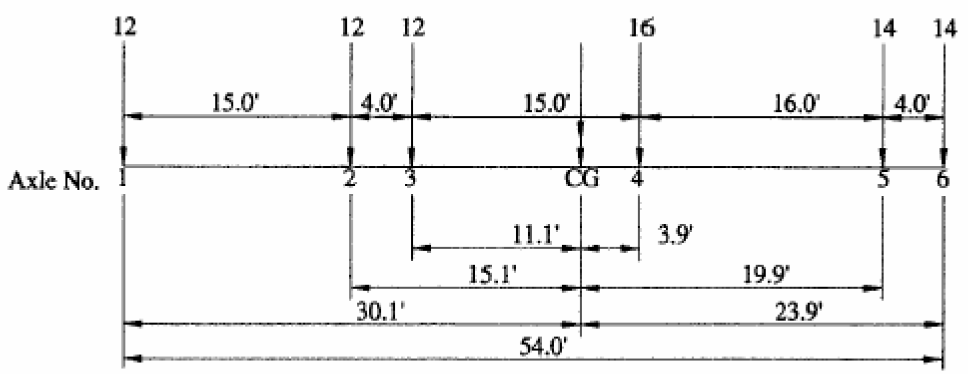

Figure B.6-4 Type 3-3 Unit WEIGHT = 80 kips (40 tons).

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EVALUATION PROCEDURES

EVALUATION PROCEDURES

Weigh In Motion (WIM) Studies

- ✓ Bending Plates
- ✓ Load Cells
- ✓ Wire Loops

- ✓ Number of Trucks
- ✓ Axle Weights
- ✓ Axle Spacing

- ✓ Equivalent Fatigue Truck

EVALUATION PROCEDURES

Weigh In Motion (WIM) Studies

EVALUATION PROCEDURES

Effective Stresses

$$(\Delta f)_{eff} = R_s \Delta f$$

Measured Effective Stresses

- ✓ Miner's Rule

$$(\Delta f)_{eff} = R_s \left(\Sigma \gamma_i \Delta f_i^{\ 3} \right)^{\frac{1}{3}}$$

EVALUATION PROCEDURES

Partial Load Factors

$$R_s = R_{sa} R_{st}$$

- ✓ Uncertainty in Stress Range
- ✓ Uncertainty in Analysis Methods
- ✓ Uncertainty in Truck Weight

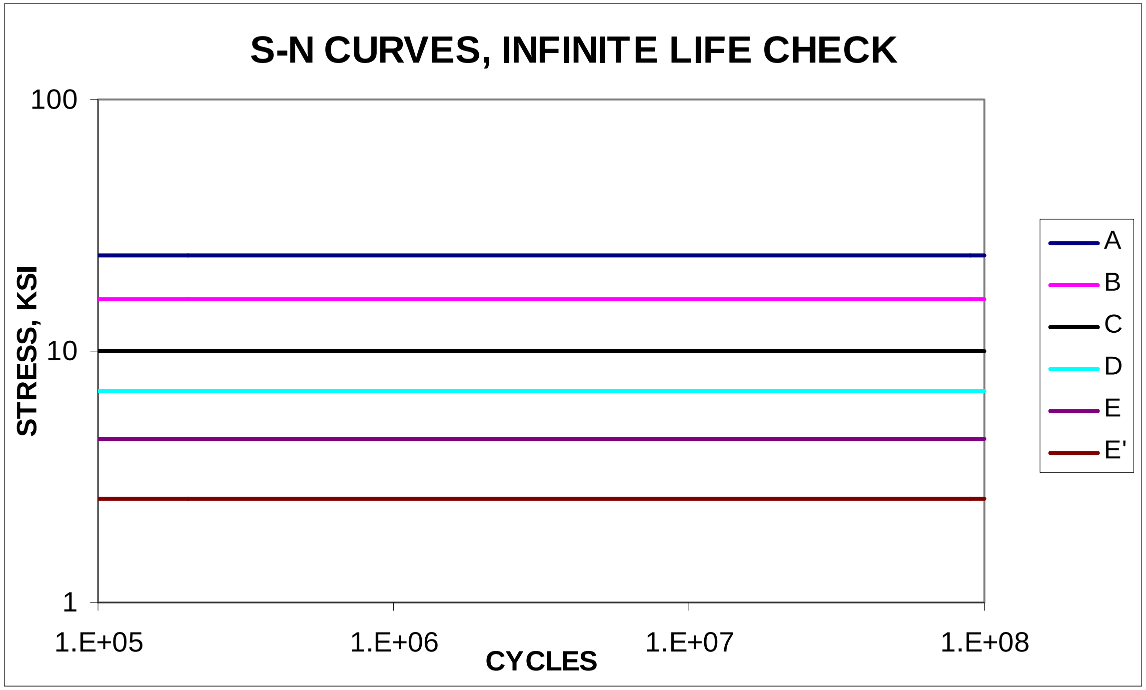
Table 7-1, Partial Load Factors: R_{sa}, R_{st}, and R_s

Evaluation Method	Analysis, R_{sa}	Truck Weight, R_{st}	Stress Range Estimate, R_s
Evaluation or Minimum Fatigue Life			
SR: Simplified Analysis TW: AASHTO Fatigue	1.0	1.0	1.0
SR: Simplified Analysis TW: WIM	1.0	0.95	0.95
SR: Refined Analysis TW: AASHTO Fatigue	0.95	1.0	1.0
SR: Refined Analysis TW: WIM	0.95	0.95	0.90
SR: Field Measurements	NA	NA	0.85
Mean Fatigue Life			
All Methods	NA	NA	1.0

EVALUATION PROCEDURES

Infinite Life Check

$$(\Delta f)_{\max} \leq (\Delta F)_{TH} \qquad (\Delta f)_{\max} = 2.0(\Delta f)_{eff}$$



EVALUATION PROCEDURES

Estimating Finite Fatigue Life

✓ Design (Minimum) Life	2σ	0.98
✓ Evaluation Life	1σ	0.85
✓ Mean Life	0σ	0.50

$$Y = \frac{R_R A}{365n(ADTT)_{SL}((\Delta f)_{eff})^3}$$

Y = Total Years

Remaining Life = Y-Present Age

EVALUATION PROCEDURES

Resistance Factors

Table 7-2, Resistance Factor, R_R			
Detail Category	Minimum (Design) Life	Evaluation Life	Mean Life
A	1.0	1.7	2.8
B	1.0	1.4	2.0
B'	1.0	1.5	2.4
C	1.0	1.2	1.3
C'	1.0	1.2	1.3
D	1.0	1.3	1.6
E	1.0	1.3	1.6
E'	1.0	1.6	2.5

EVALUATION PROCEDURES

Estimating Stress Cycles

- ✓ ADTT – Single Lane
  - ✓ Figure C7-1
- ✓ No. of Cycles per Truck
  - ✓ Same as Design
  - ✓ Influence Lines
  - ✓ Field Measurements

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EVALUATION PROCEDURES

Influence Lines

EVALUATION PROCEDURES

Other Considerations

- ✓ Riveted Details
  - ✓ Category C instead of D (Design)
- ✓ Compressive Stresses
  - ✓ LL Tensile Stress must be at Least Twice DL Comp.
  - ✓ Consider Load used in the Evaluation

RESULTS

When to Evaluate:

- ✓ Detail Categories C-E'
- ✓ Consider Traffic
- ✓ Consider Stresses
- ✓ Consider Consequences
- ✓ ***Document***

If Results Are Unacceptable:

- ✓ Refine Analyses Parameters
  - ✓ Balance Costs vs. Savings
- ✓ Access Risk and Consequences
  - ✓ Increase Monitoring
- ✓ Retrofit

2005 Tri-Service Infrastructure Systems Conference

Evaluation of Stilling Basin Performance for Uplift Loading Due to Historic Flows

US Army Corps of Engineers ®
Sacramento District

HDR

Rick L Poeppelman, P.E. – USACE

Peter J Hradilek, Ph.D., P.E., G.E.
Yunjing (Vicky) Zhang, P.E.
HDR Engineering

Aug. 2005

Introduction

- **Built in 1950s**
- **340’ Concrete Section**
- **8 Operating Spillway Gates**
- **Stilling Basin**

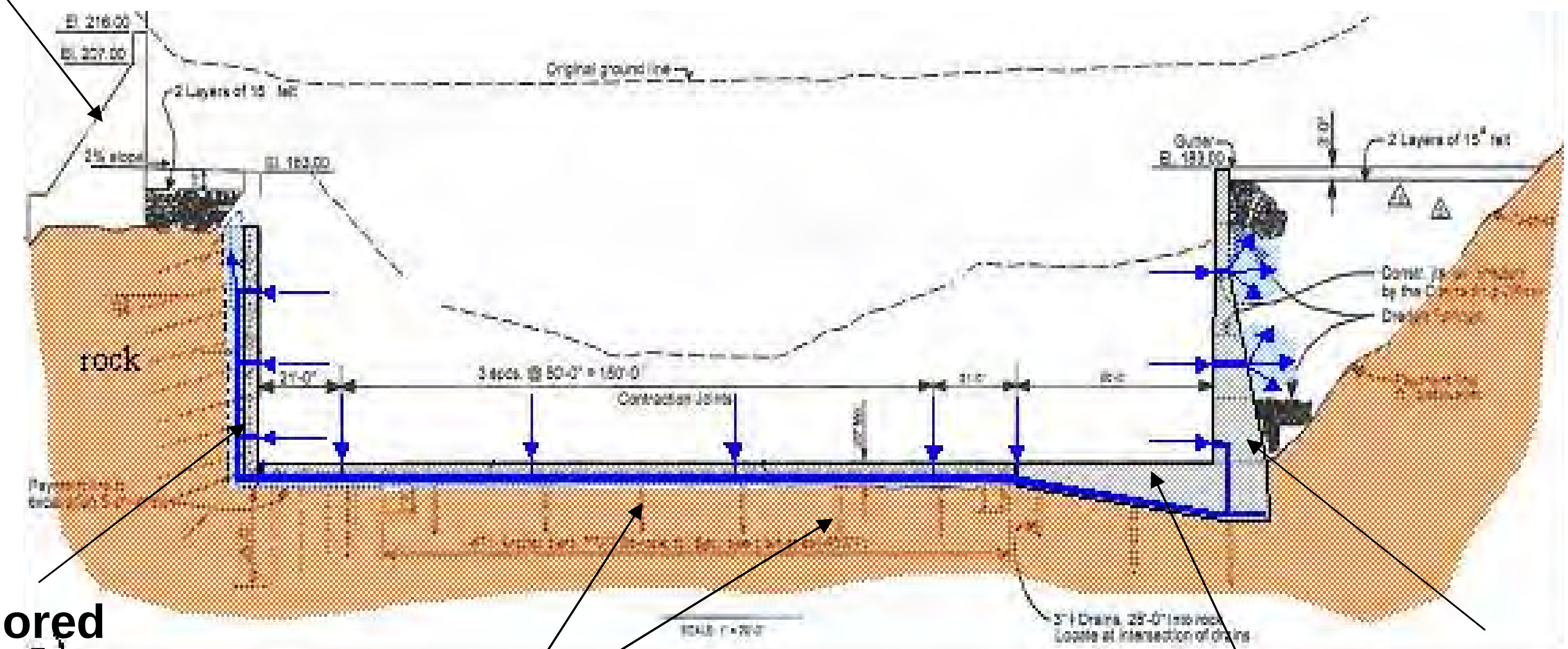
Background

- Outlets - Enlarging 8 existing, adding 2 new upper tier
- Increasing outlet discharge capacity from 25,000 cfs to 115,000 cfs
- Flood control protection from 1 in 100 to 1 in 140

Transverse Cross-Section of Stilling Basin Geometry

Gravity Wall

Looking Upstream



Anchored Wall

L -Wall

#11 bars @ 5 ft, 7' into rock

No anchor

Design Criteria

USACE Engineer Circular and Manuals

- EC 1110-2-6058 “Stability Analysis of Concrete Structures”
- EM 110-2-2104 “Strength Design for Reinforced-Concrete Hydraulic Structures”
- EM 1110-2-2200 “Gravity Dam Design”

Parameters in New Anchor Design

- Load Condition: Unusual
- 0.9-Strength design factor for tension (ACI 318-99)
- 1.7-Single load factor for (D+L) (EM 1110-2-2104)
- 1.65-Hydraulic load factor in tension (EM 1110-2-2104)
- 0.75-Short duration/Low probability loading condition

New Anchors for Stilling Basin

- Hydrodynamic pressure decides the strength of anchor
  - Pre-stressed 1-3/8”, 25’ long @ 5’ o.c

- Hydrostatic pressure decides the length of anchor

Historic Flows

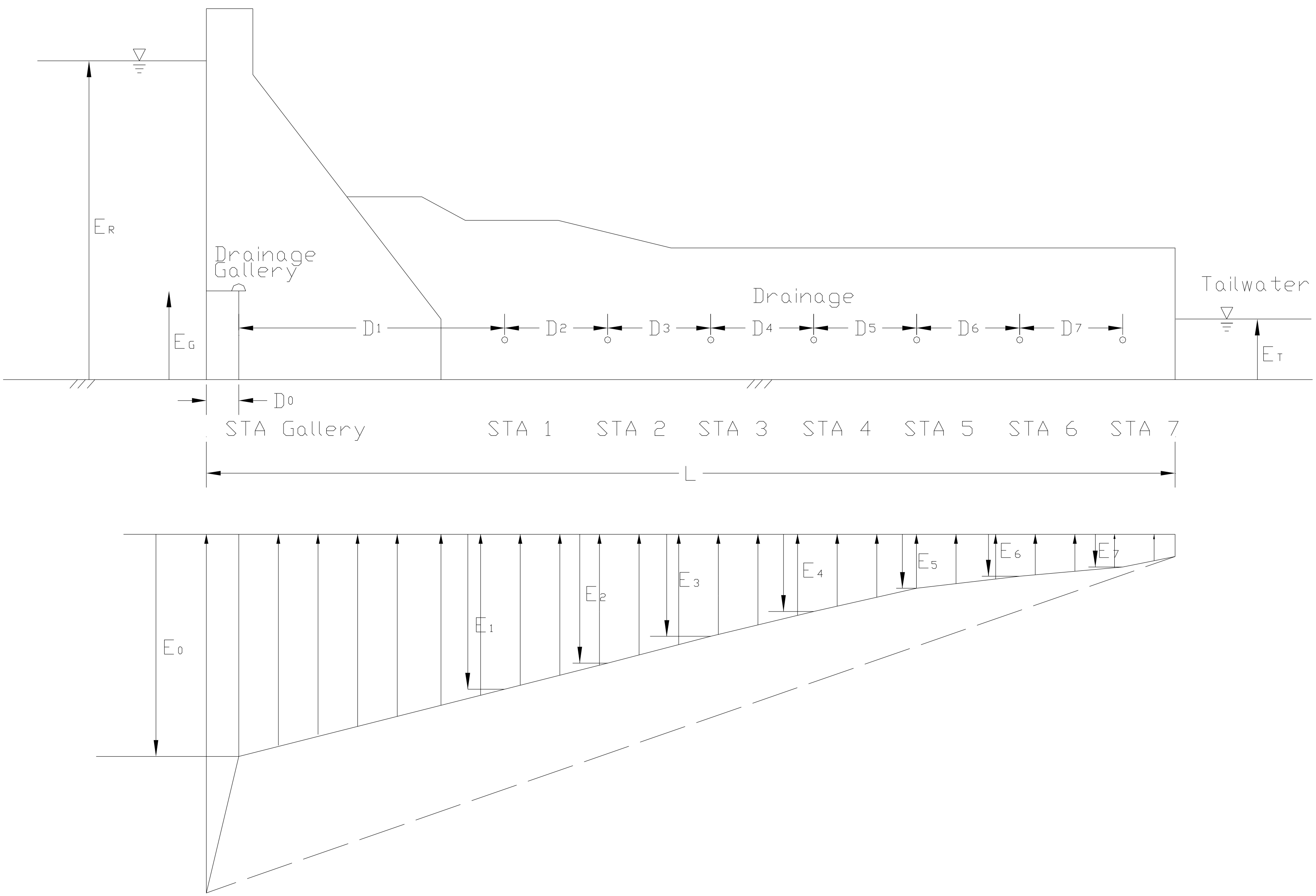
1. 115,000 cfs spillway flows; reservoir elevation 466
   - Dec. 64: 115,000 cfs; high flows over a 50 hour period; reservoir elevation 456
   - Feb. 86: 130,000 cfs; high flows over a 64 hour period; reservoir elevation 466
   - Jan. 97: 116,100 cfs; high flows over a 35 hour period; reservoir elevation 456

Historic Flows

2. Maintenance Condition (stilling basin dewatered; reservoir elevation 450)
   - Sep. 65: reservoir elevation 442
   - Jun. 97: reservoir elevation 442

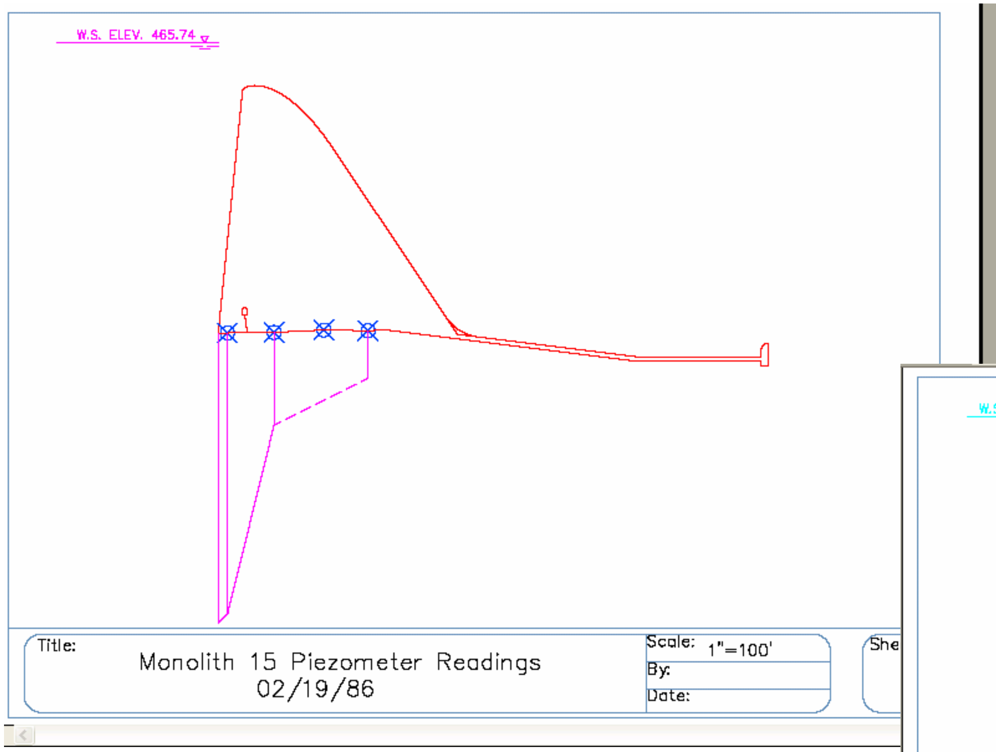
Stilling basin did NOT exhibit any flotation stability problems either during or after any of these events

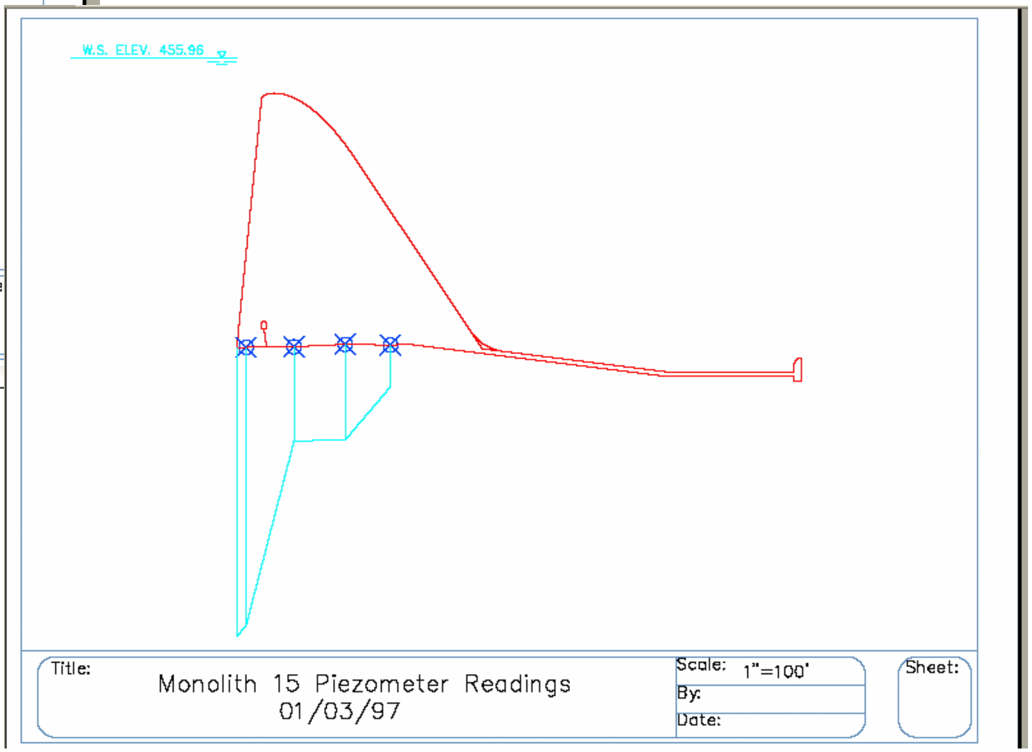
Uplift



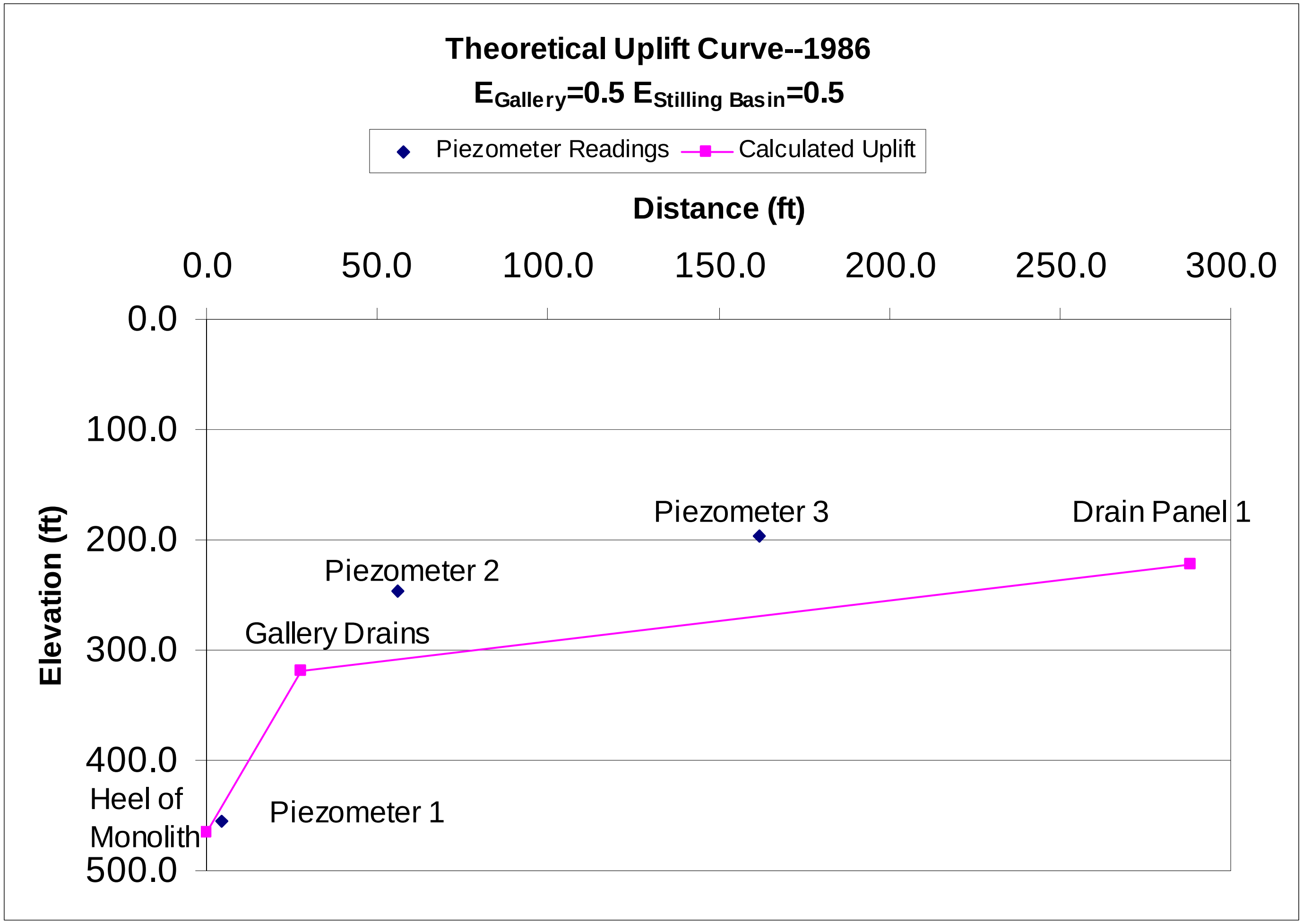
ER
Drainage
Gallery
EG
D1
D2
D3
D4
D5
D6
D7
Drainage
Tailwater
ET
D0
STA Gallery
STA 1
STA 2
STA 3
STA 4
STA 5
STA 6
STA 7
L
E0
E1
E2
E3
E4
E5
E6
E7

Piezometer Location



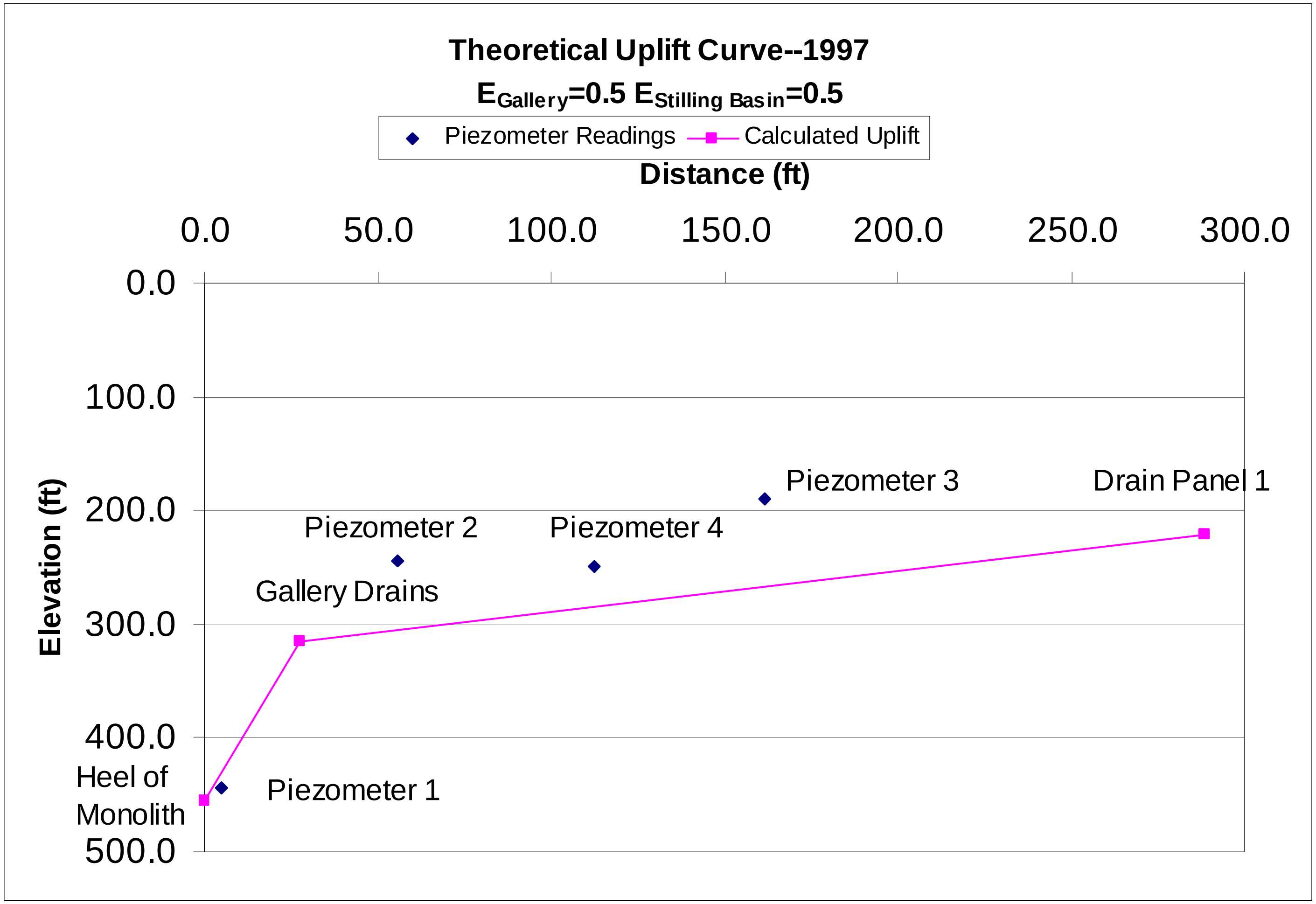


Theoretical Uplift Curve at 1986



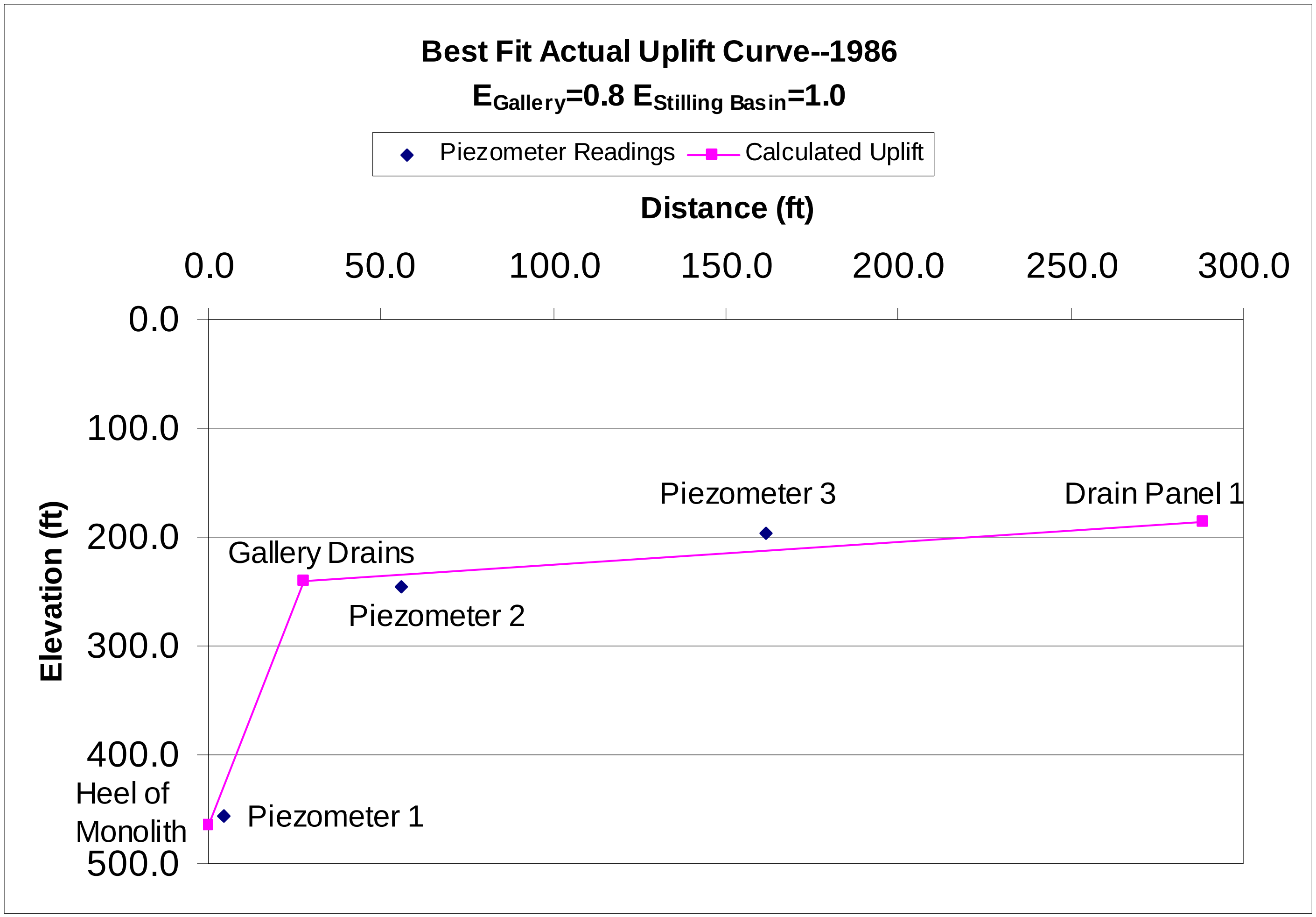
$E_{Gallery}$= 0.5 and $E_{Stilling\ Basin}$= 0.5

Theoretical Uplift Curve at 1997



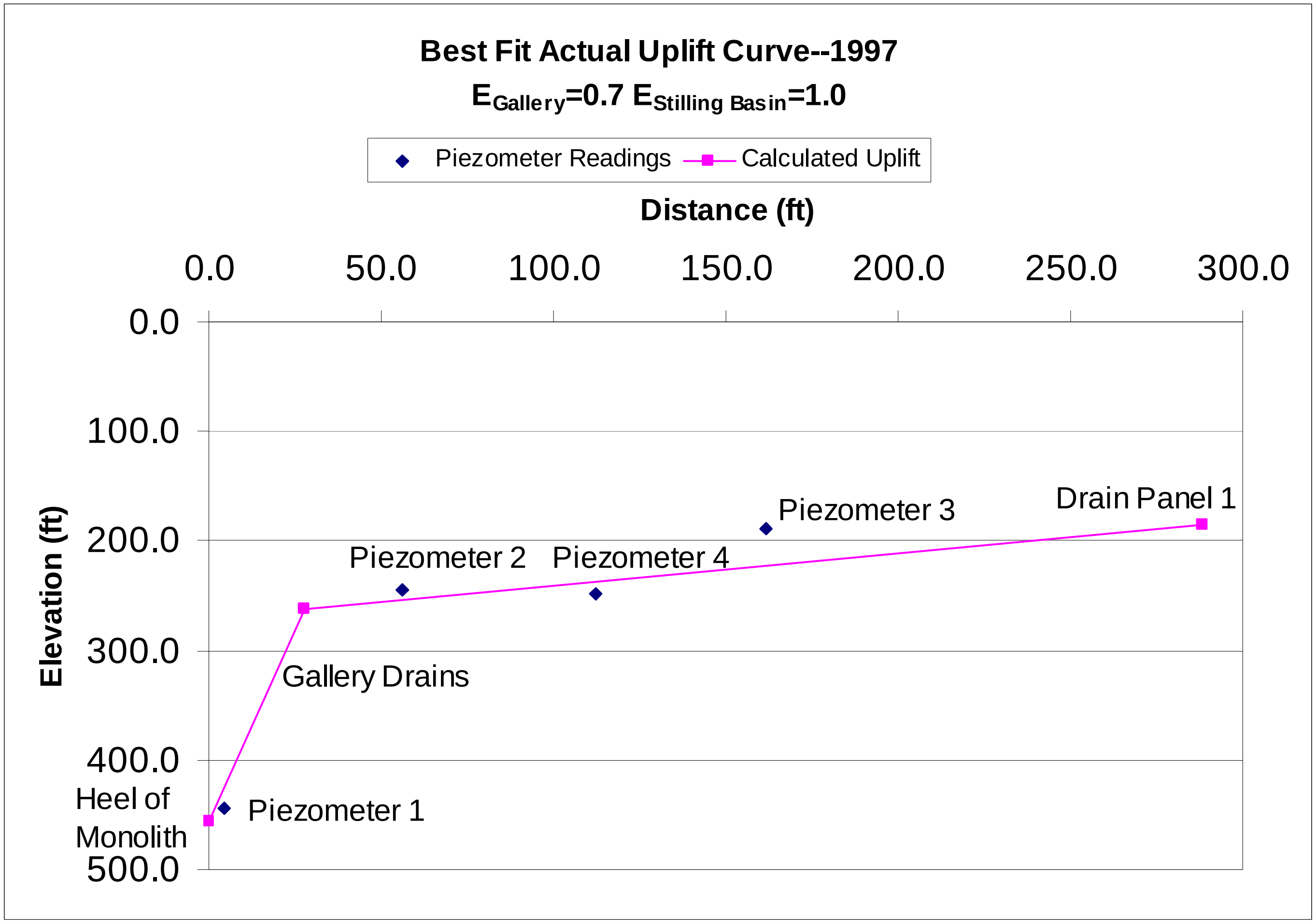
$E_{Gallery}$= 0.5 and $E_{Stilling\ Basin}$= 0.5

Best fit actual uplift curve at 1986



$E_{Gallery}$= 0.8 and $E_{Stilling\ Basin}$= 1.0

Best fit actual uplift curve at 1997



$E_{Gallery}$= 0.7 and $E_{Stilling\ Basin}$= 1.0

Comparison of Design Loading and Historic Flows

Peak Net Uplift Loading (ft) for Upstream Portion

Row 1 Station 12+46.5	Operating Case 1B	Dec. 1964 Loading	Feb. 1986 Loading	Jan. 1997 Loading
L	49.5	49.0	50.9	48.9
E	58.7	57.8	60.0	57.7
D	67.8	66.6	69.1	66.5
C	66.5	65.4	67.9	65.3
B	51.3	50.7	52.6	50.6
A	40.4	40.3	41.8	40.1

Comparison of Design Loading and Historic Flows

Peak Net Uplift Loading (ft) for Downstream Portion

Row 5 Station 14+46	Maintenance Case	1965 Dewatering	1997 Dewatering
L	15.9	15.9	15.9
E	16.5	16.4	16.4
D	17.1	17.0	17.0
C	17.0	17.0	17.0
B	16.0	16.0	16.0
A	15.3	15.3	15.3

Are the criteria conservative?

- The actual uplift forces are NOT as high as the calculated theoretical ones
- There are no continuous cracks in the block of rock at a plane near the end of the anchors to allow the block to readily separate from the rock mass underneath
- The drain effectiveness is more than the assumed 50%

Conclusions

- The existing anchorage of the stilling basin slab has demonstrated repeatedly to be sufficient to withstand the design hydrostatic uplift loading
- The standard assumptions in the criteria for new designs are overly conservative
- Adding new anchors and drains will increase the stilling basin's resistance to uplift forces

Recommendation

"***It may not be necessary to modify an existing structure that does not satisfy the requirements for new structures, when there are no indications of any stability problem.***"

USACE EC 1110-2-6058 "Stability Analysis of Concrete Structures", Chapter 7 "Evaluating and Improving Stability of Existing Structures"

Questions?

2005 Tri-Service Infrastructure Systems Conference

Modification of Folsom Dam Stilling Basin for Hydrodynamic Loading

US Army Corps of Engineers®
Sacramento District

HDR

Rick L Poeppelman, P.E. – USACE

Yunjing (Vicky) Zhang, P.E.
Peter J Hradilek, Ph.D., P.E., G.E.
HDR Engineering

Aug. 2005

Overview

- Built in 1950s
- 340’ Conc.
- 5 operating gates
- 3 emergency gates
- Outlets
- Stilling basin
- Walls

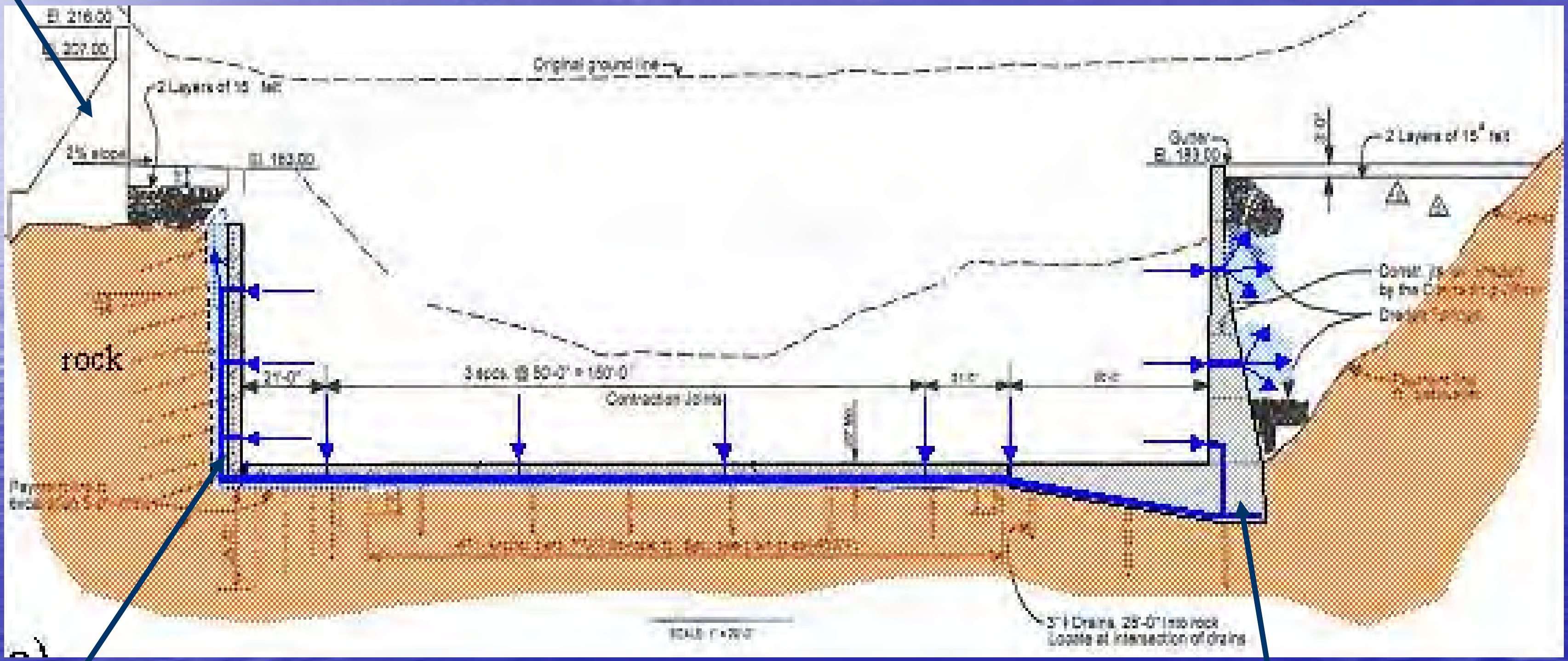
Introduction

- A multipurpose dam
- Reservoir capacity – 975,000 ac-ft
- Objective flood control release of 115,000 cfs

Transverse Cross-Section of Stilling Basin Geometry

Gravity Wall

Looking Upstream



L Wall

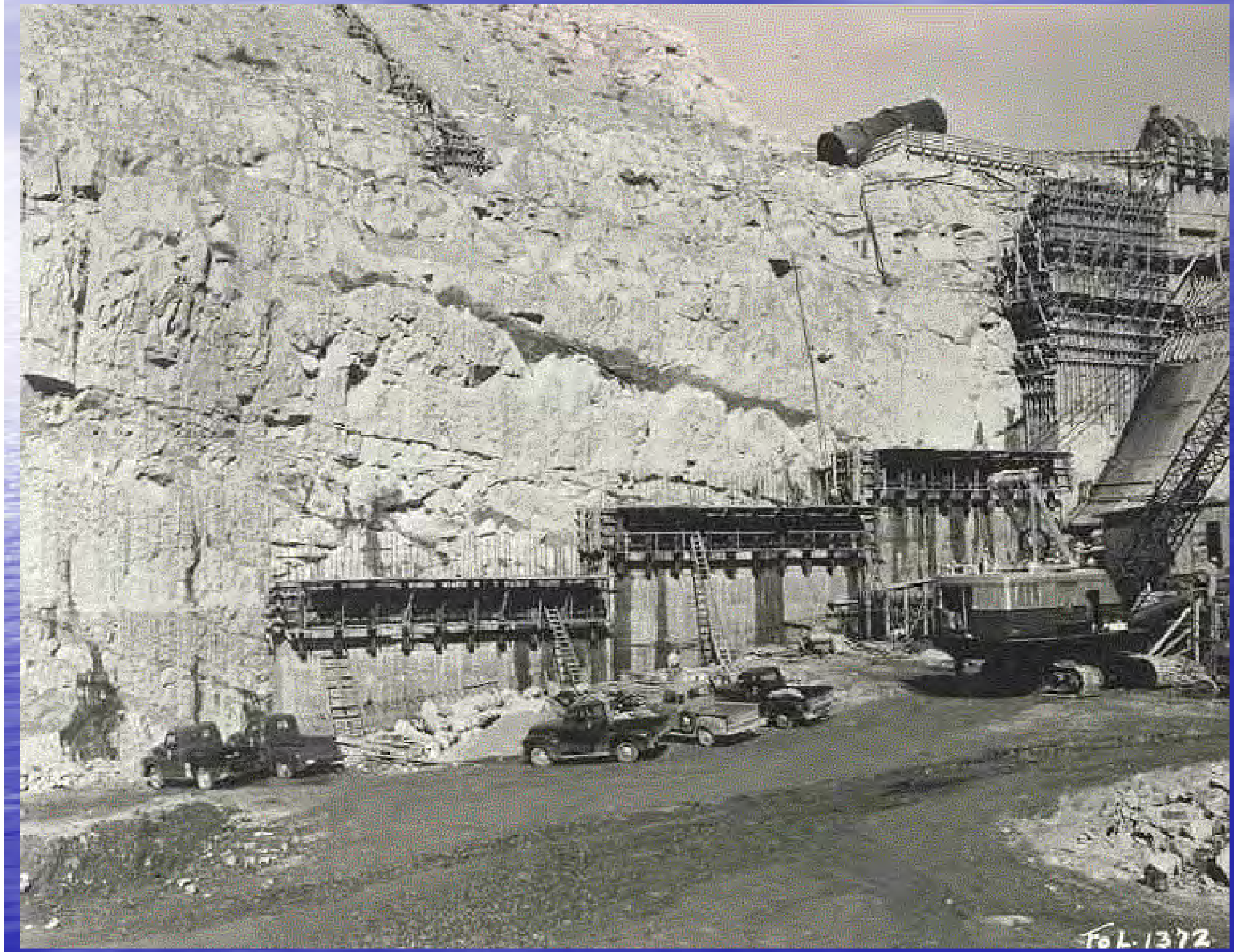
Anchored Wall

HDR

Stilling Basin Floor

- 349’ long and 242’ wide, 5’ concrete slab
- #11 @ 5’ o.c, 7’ into rock
- Dental concrete to level slab

Right Wall



- Hang-on type wall
- 372’ Long
- 43’ – 73’ tall
- #11 @5’ o.c, 25’ into rock
- Gravity Wall
- 164’ Long (total)
- 15’ – 32’ tall

L - Wall

- Reinforced concrete L-type
- 372’ Long
- 76’ - 68’ tall
- Dredge tailings (cobbles)

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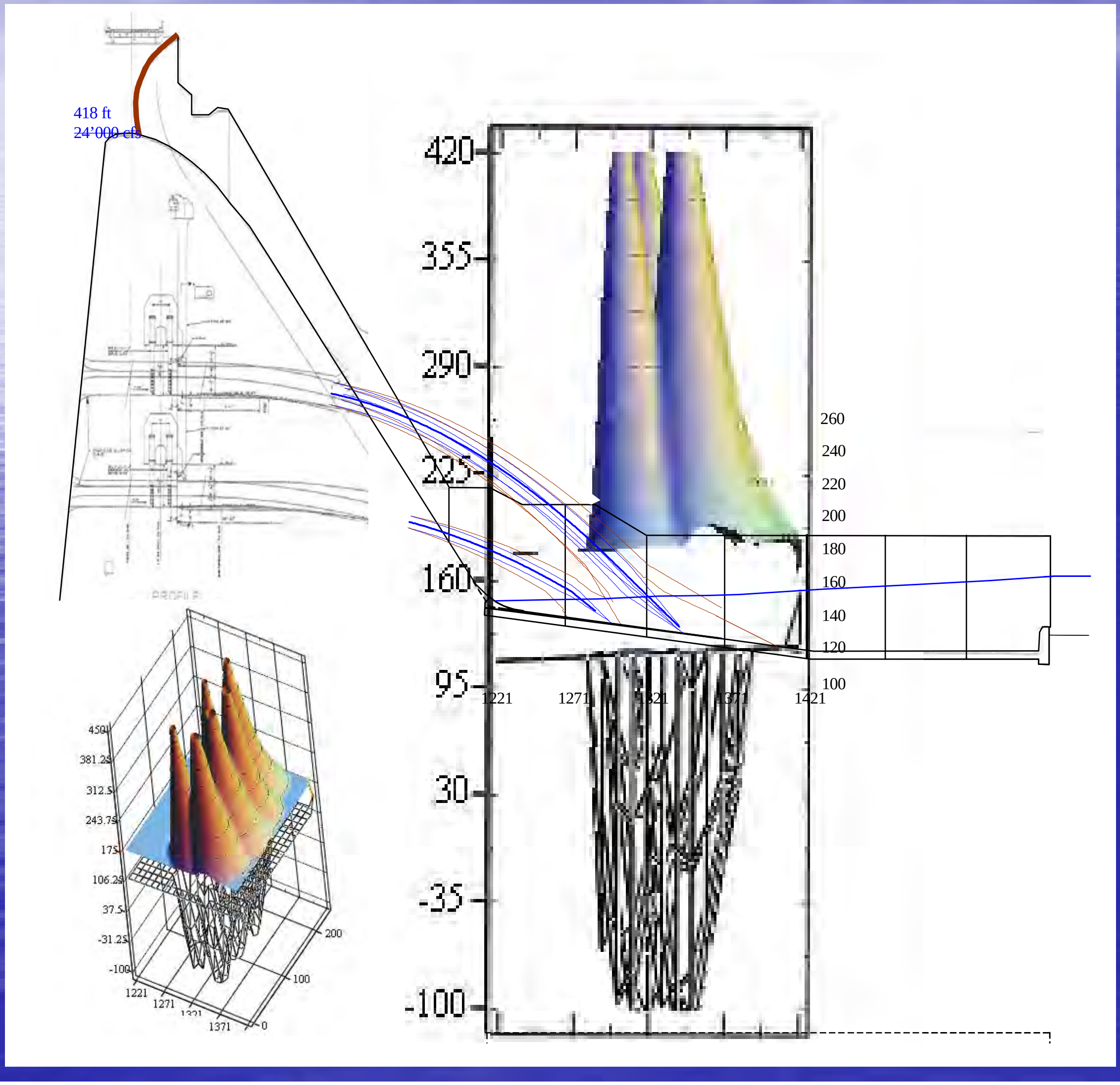
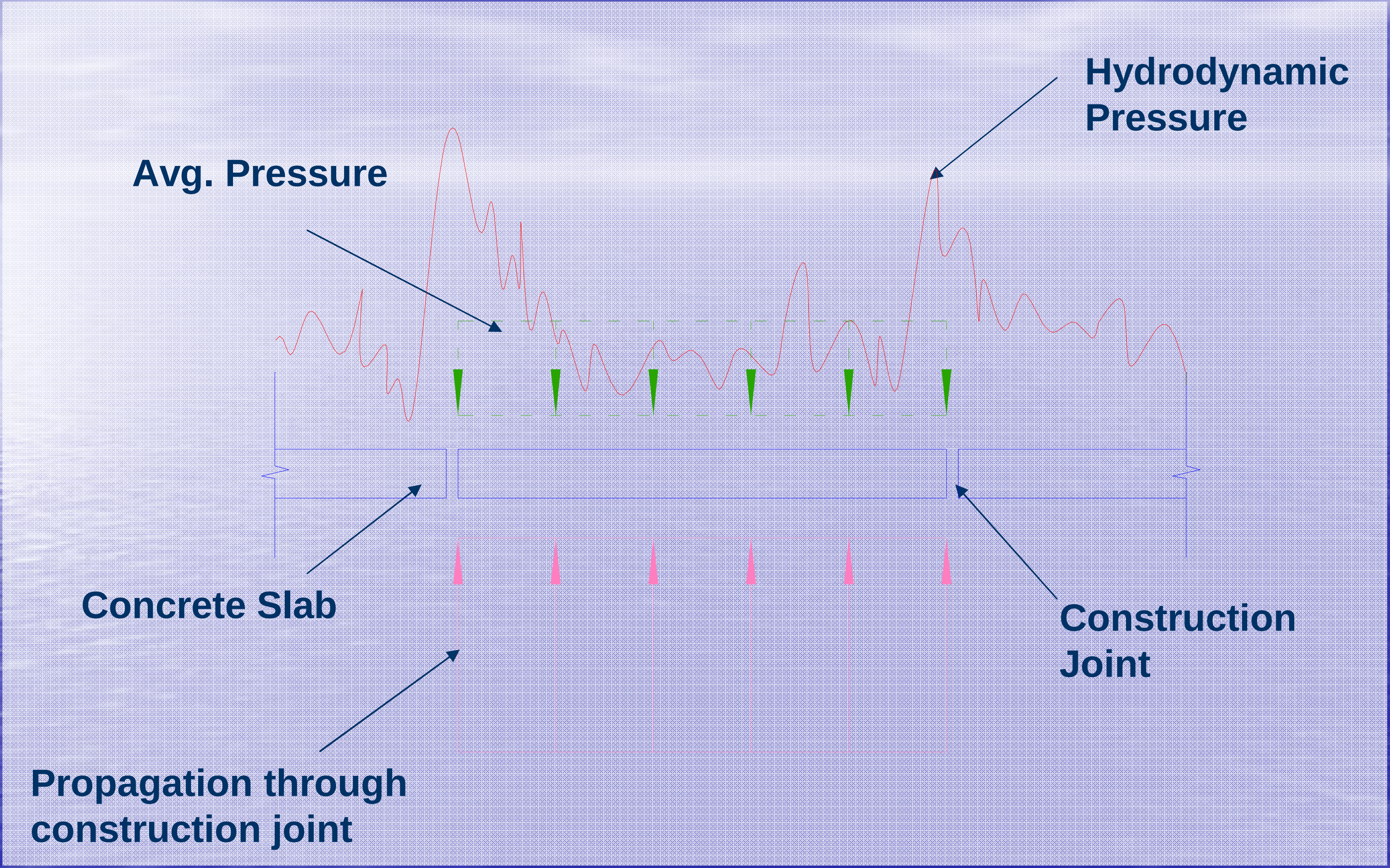
Design Concern - Extreme Dynamic Pressure



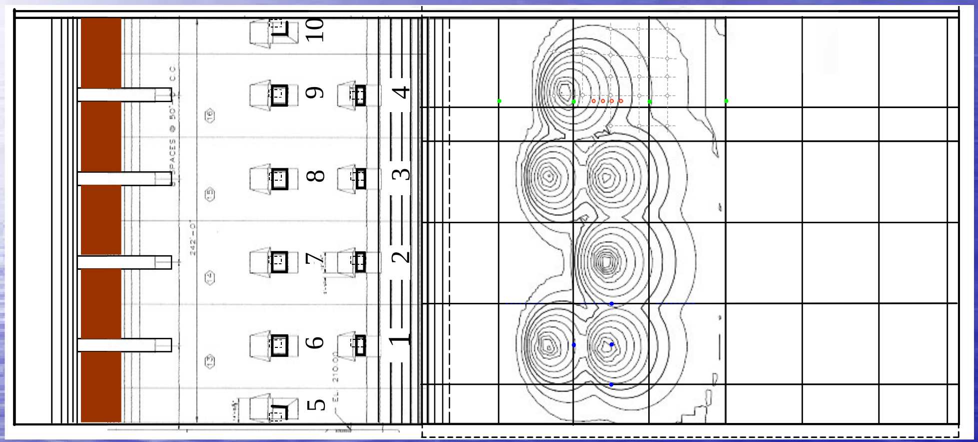
- **Failures** (Karnafuli and Malpaso Dams)
- **Background**
- **Propagation**
- **Numerical Model**
- **Physical Model**

Hydrodynamic Pressures



Dynamic pressure patterns on a concrete slab

Extreme Dynamic Pressure
Probability



- Once in every 10 yrs (Continuous operation)
- Once in every 146,000 yrs (Real Life)
- Folsom dam – 1 in 3.75 days (continuous)
- Return periods of 150 years
- Spillway and outlet flows

HDR

Physical Model

USBR - Denver Hydraulic Laboratory

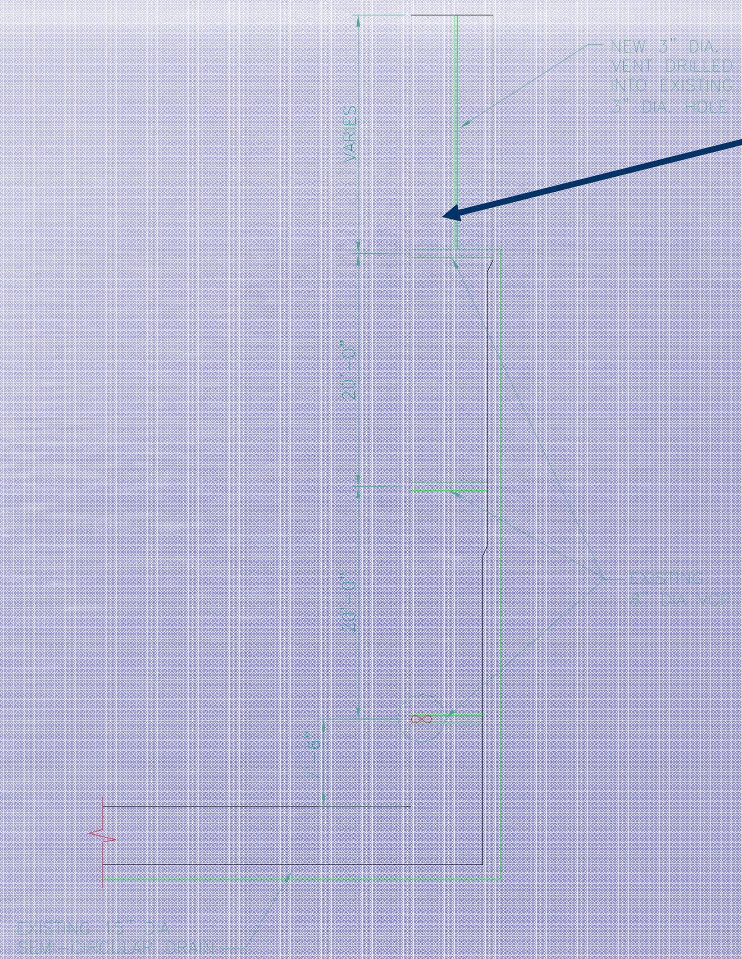
Spillway Flows / Outlet Flows

Drain Modifications

Dewatering – Oct 10,2004

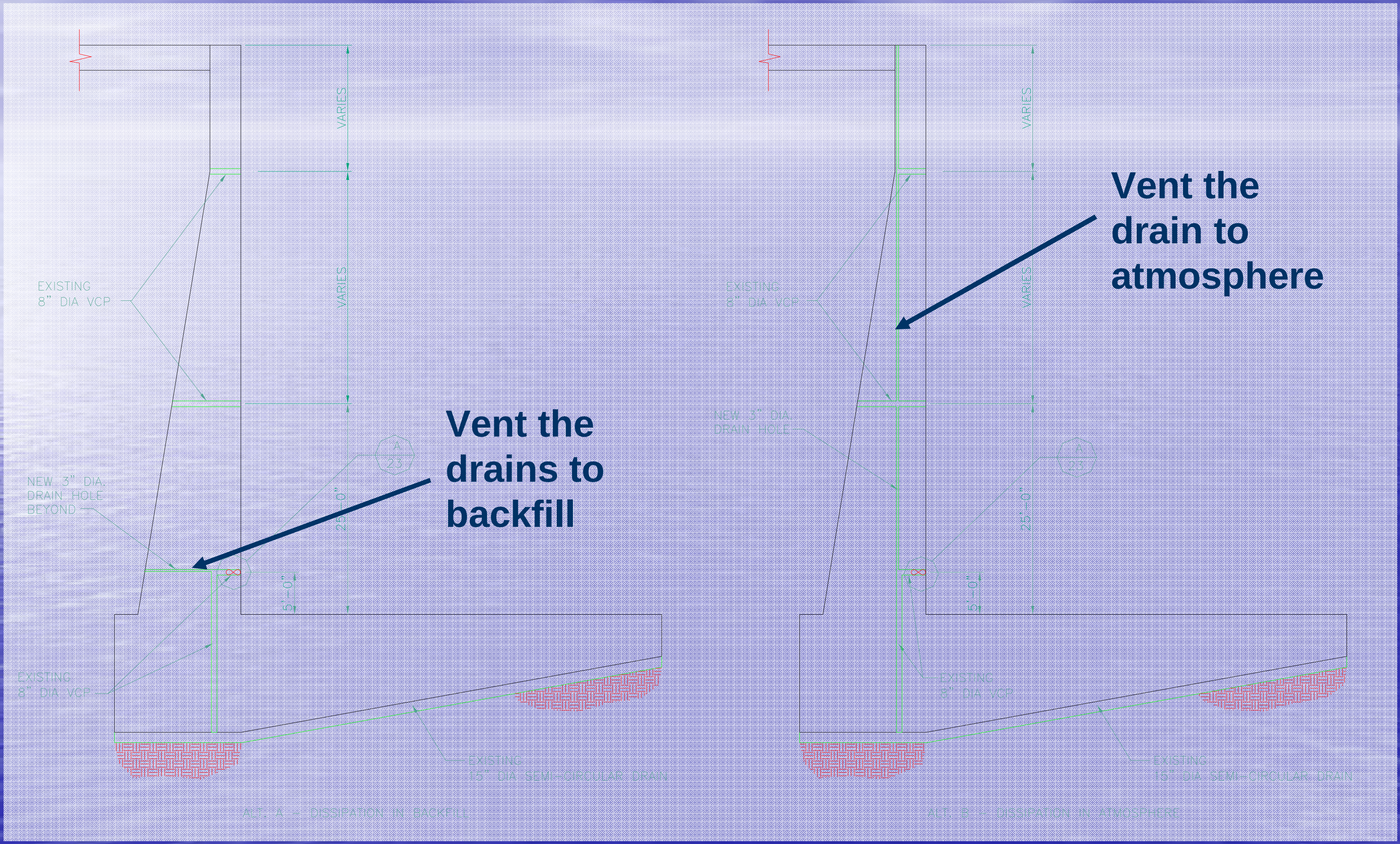
- Modify the drains to mitigate the propagation of hydrodynamic pressures into the drain system

Right Wall Drainage

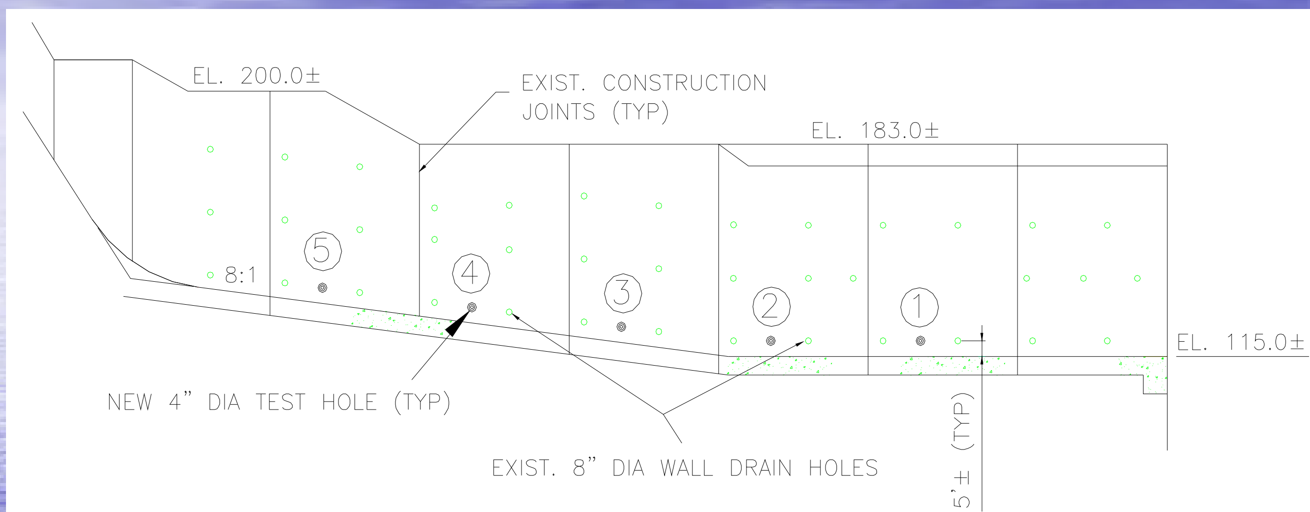


Vent the drains to atmosphere

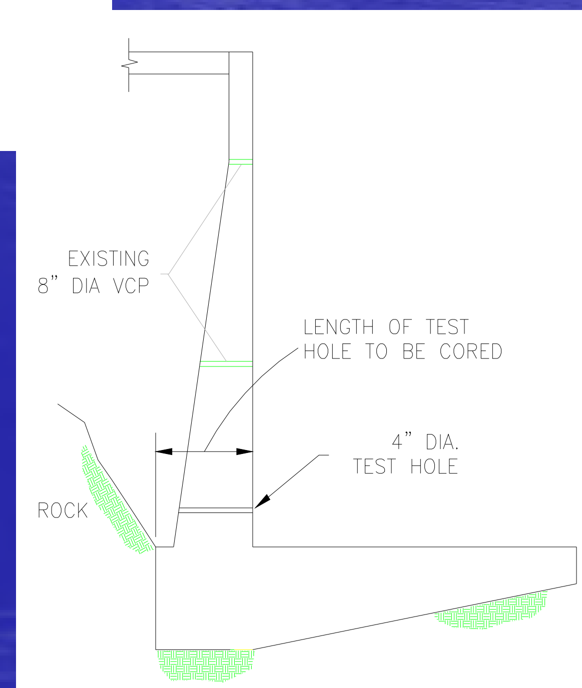
L-Wall Drainage Alternatives



L-Wall Backfill Pressure Dissipation Test



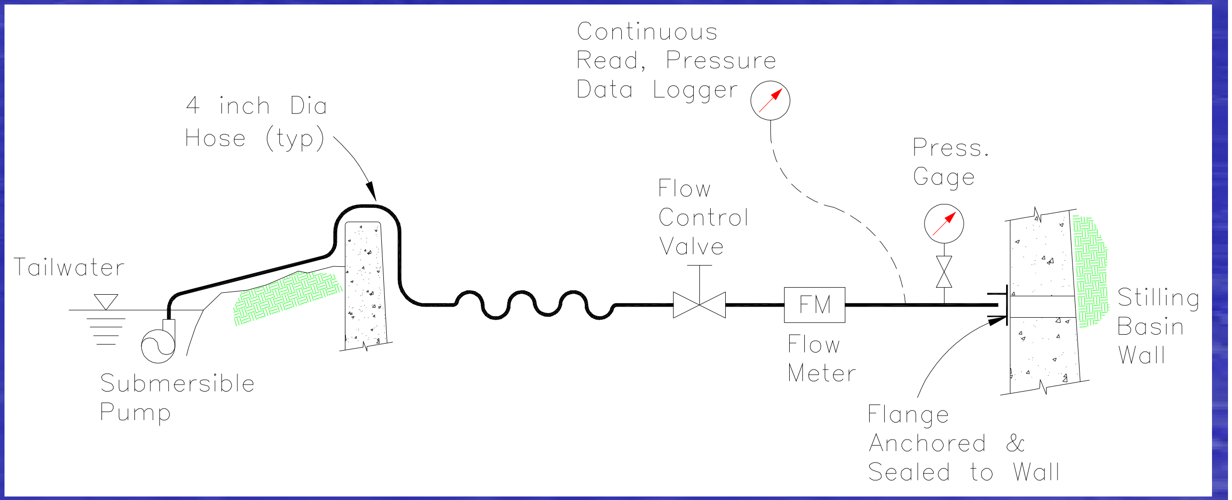
L-Wall Section



L - Wall Test Hole

L-Wall Backfill Pressure Dissipation Test Equipments

- Pressure
- Flow rate
- Duration of pump



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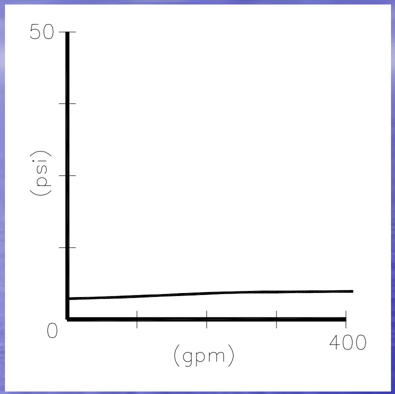
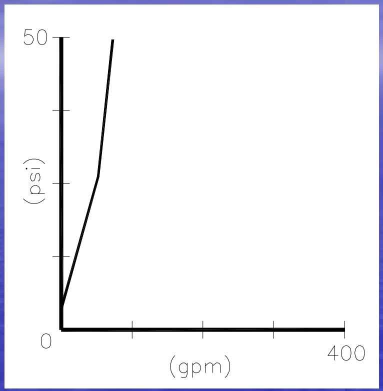
L-Wall Backfill Pressure Dissipation Test

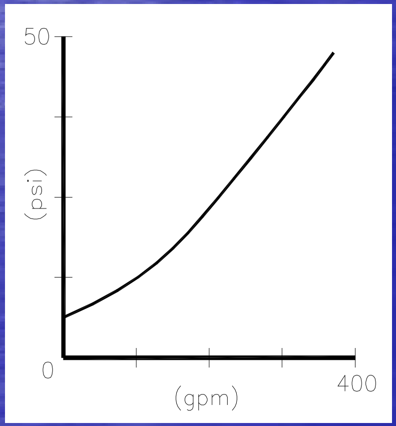
Potential Outcomes



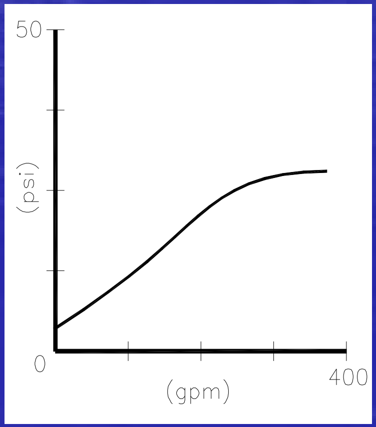
High flow v. low pressure graph



High pressure v. low flow graph



Linear flow v. pressure graph



Stabilized flow v. pressure graph

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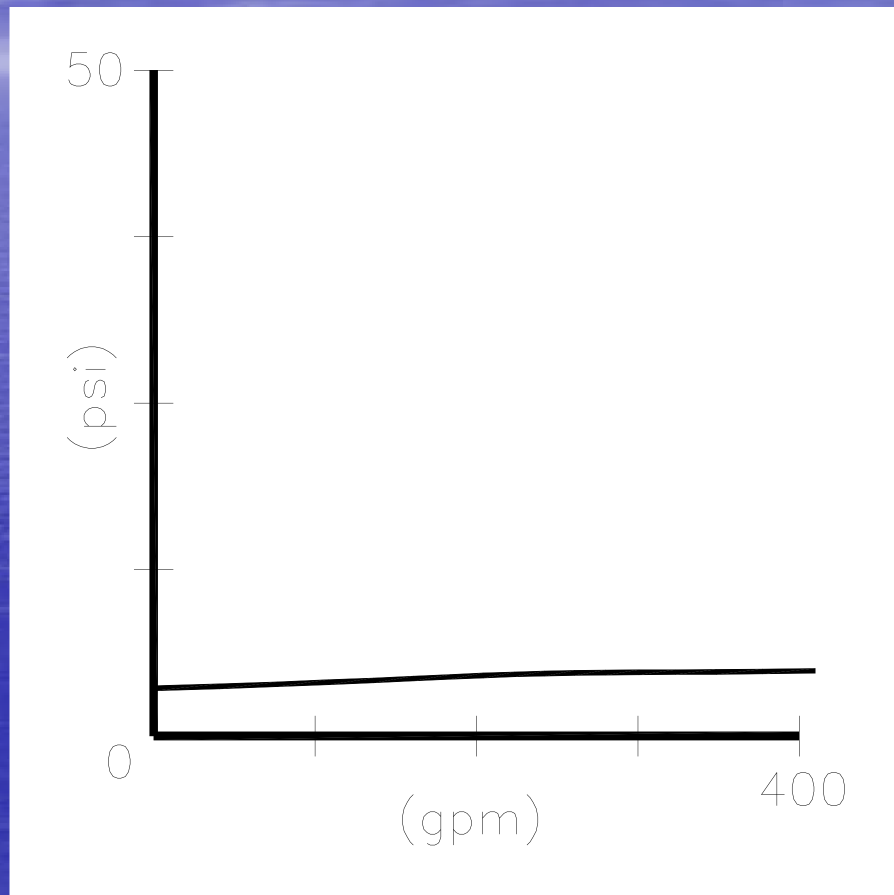
L-Wall Backfill Pressure Dissipation Test

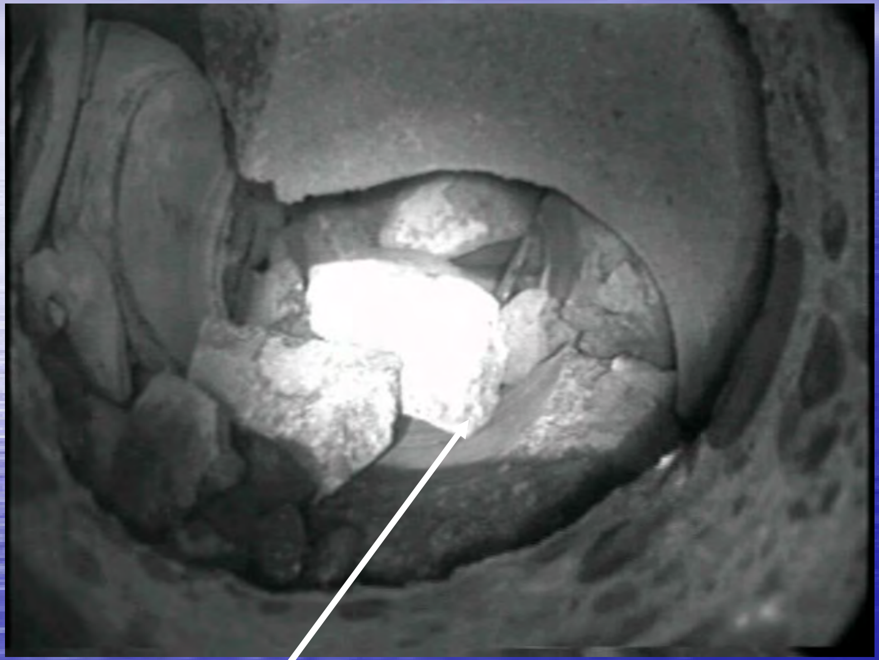
Actual Outcome



High flow v. low pressure graph

L-Wall Backfill Pressure Dissipation Test

Backfill from Hole Video Survey



Dredge Tailings (Cobble)

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Stilling Basin Rehabilitation

Loading Cases

- Maintenance condition (stilling basin empty)
- Rapid closure of gates
- Operating case 1A (design outlet flows)
- Operating case 1B (design spillway flows)
- OBE (Operational Basis Earthquake) loading
- MCE (Maximum Credible Earthquake) loading

Stilling Basin Rehabilitation
Criteria

- USACE criteria for hydraulic structures
  - ✓1.65 – Hydraulic load factor for tension
  - ✓1.70 – Single Load factor (Dead and live load)
  - ✓0.90 – Strength design factor for tension
  - ✓0.75 – Short duration/Low probability loading condition
- Working stress of 32% of ultimate anchor strength

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Stilling Basin Rehabilitation

- Hydrodynamic and hydrostatic loading cases
- Earthquake loading:
  - OBE: a_h= 0.07g and a_v=0.02g
  - MCE: a_h= 0.25g and a_v=0.08g
- Partial Blocks
  - Horizontal faults in the existing rock
- Gravity Wall Extensions
  - 25′ to 51′ long
  - 10′ spacing at U/S, 5′ spacing at D/S
  - Lock off loads: 12 – 71 kips

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Stilling Basin Rehabilitation
Tie-Downs and Tie-Backs

- Hydrodynamic pressure controls tie-down/tie-back strength
- Hydrostatic pressure controls length

- Tie-down - Prestressed 1-3/8" anchor bar 25′ long, 5′ (or 10′) on center
- Tie-back - Prestressed 1-3/8" anchor bar, 25′ – 43′ long, 5′ on center, lock-off load: 53-249 kips

Conclusions

- Both hydrostatic and hydrodynamic design should be included
- Drain modifications will mitigate the extreme hydrodynamic pressure

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Questions???

HDR

OBERMEYER GATED SPILLWAY S381

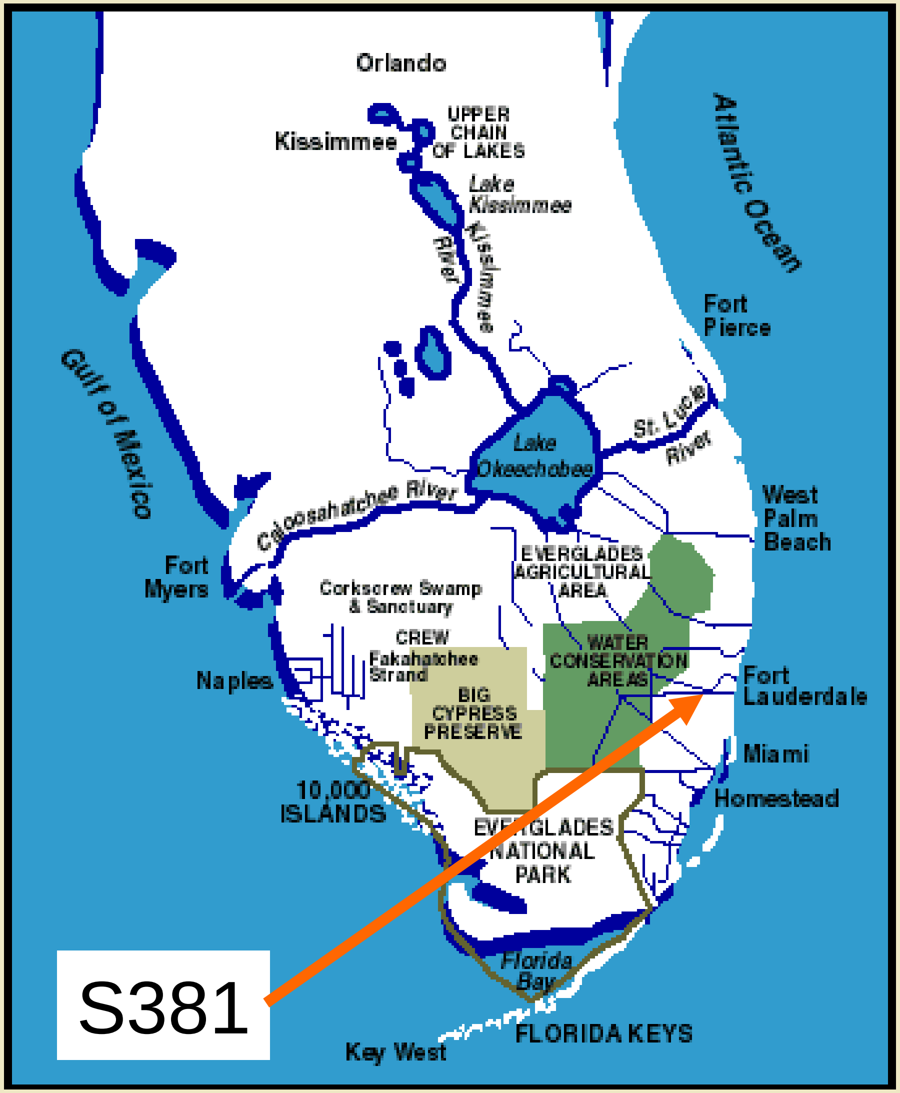
Jacksonville District 2005

General Information

- S381 is a 3 bay broad crested spillway structure equipped with Obermeyer gates that was completed in March 2005 for $5.5 million
- Designed as a water quality structure
- Purpose is to prevent urban runoff from communities west of Ft. Lauderdale from flowing west to water conservation areas
- 2,880 CFS discharge capacity

General Information (Cont.)

- Spillway is located along the C-11 Canal in Southeast Florida, west of Fort Lauderdale, Florida.



Background Information

- The original design called for a 2 bay vertical lift gated/ogee weir spillway structure in C-11 canal.
- Vertical lift gate structure was under construction.

Problems with Old Design

- Topography in area very flat, heavily developed
- Problems and concerns surfaced with the hydraulic design
- Local drainage districts upstream of the spillway realized that the 6” head differential created across structure meant more potential flooding than without project condition
- H&H design approach was for water quality - did not perform modeling of the watershed area to the east for flooding

Solution

- Decision made to abandon vertical lift gate design and redesign structure as an Obermeyer gated spillway (nearly zero head loss across structure)
- First time use for Jacksonville District
- Terminated existing construction contract
- Spillway was redesigned through an AE task order. HDR, Engineering Inc. did the new design and had previously designed one of these spillways in FL.
- NTP for construction contract was issued in October 03 and structure was completed in March 05.

Obermeyer Hydro, Inc. - Ft. Collins, CO

In business since fall ’88

Corps Work:

1) McHenry – Illinois – Fall 2001- Flood Control
2) Algonquin - Illinois – Fall 2001- Flood Control
3) Lake Traverse – Minn. – Winter 2001- Reservoir outlet
4) Flint – Michigan – Fall 2000- Water Diversion
5) Clinton Weir – Michigan – Fall 96 – Diversion
6) Saylorville Lake- Iowa – Fall 93 – Flood Control

Obermeyer Gate Details

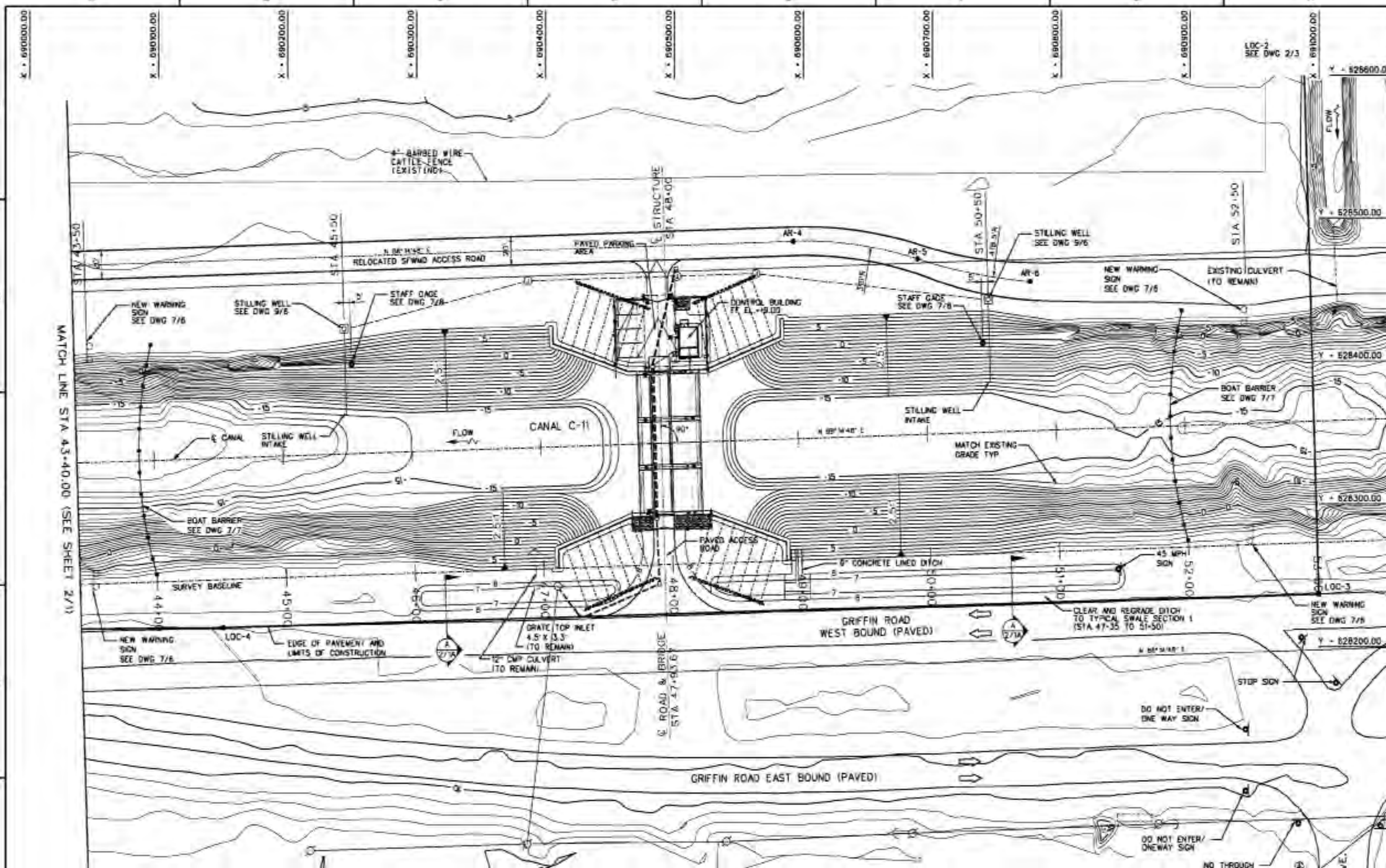
- Gates consist of two gate panels per bay supported by reinforced air bladders on the down stream side.
- Gates are raised and lowered by inflating or deflating the reinforced air bladders with compressed air.
- Gates are a bottom hinged system that are attached to the foundation with a row of anchors bolts.
- By controlling the air pressure in the bladders, the water elevations can be accurately maintained within the control range (full inflation to full deflation).

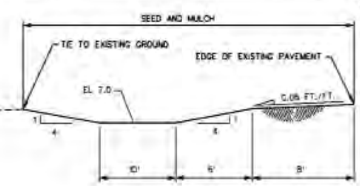
Obermeyer Gate Details (Cont.)

- Restraining straps keep gate from overturning in a reverse head condition
- Lower O&M costs associated with Obermeyer gates compared with vertical lift gate spillways.
- Cleaner water discharge with Obermeyer gates verse vertical lift gate spillways since discharge is over the top instead of from the bottom.
- OHI provides design services (calculations, drawings, etc.) for the gates.

Sole Source Issue

- Sole source justification was required by Contracting Division in order to use Obermeyer gates.
- HDR performed up to 70% of design until sole source approval.





TYPICAL SWALE SECTION
SCALE: NTS

SCALE: 1" = 30'-0"

NOTE:

1. FOR RELOCATED ACCESS ROAD CONTROL POINTS, SEE DWG 2/1A
2. FOR LOC CONTROL POINTS, SEE DWG 1/5

ITEM	DESIGNATION	NORTHING	EASTING	ELEVATION	STATION	OFFSET	DESCRIPTION
CONTROL POINTS	AR-1	628,419.56	689,686.70	N/A	N/A	N/A	℄ RELOCATED SFWMD ACCESS ROAD
	AR-2	628,443.79	689,795.94	N/A	N/A	N/A	℄ RELOCATED SFWMD ACCESS ROAD
	AR-3	628,462.32	689,892.44	N/A	N/A	N/A	℄ RELOCATED SFWMD ACCESS ROAD
	AR-4	628,483.74	690,592.11	N/A	N/A	N/A	℄ RELOCATED SFWMD ACCESS ROAD
	AR-5	628,471.42	690,688.62	N/A	N/A	N/A	℄ RELOCATED SFWMD ACCESS ROAD
	AR-6	628,455.88	690,775.99	N/A	N/A	N/A	℄ RELOCATED SFWMD ACCESS ROAD

US Army Corps of Engineers
Jacksonville District

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DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

HDR ENGINEERING, INC.
2202 N. WEST SHORE BLVD.
SUITE 250
TAMPA, FL 33607
CA 4213

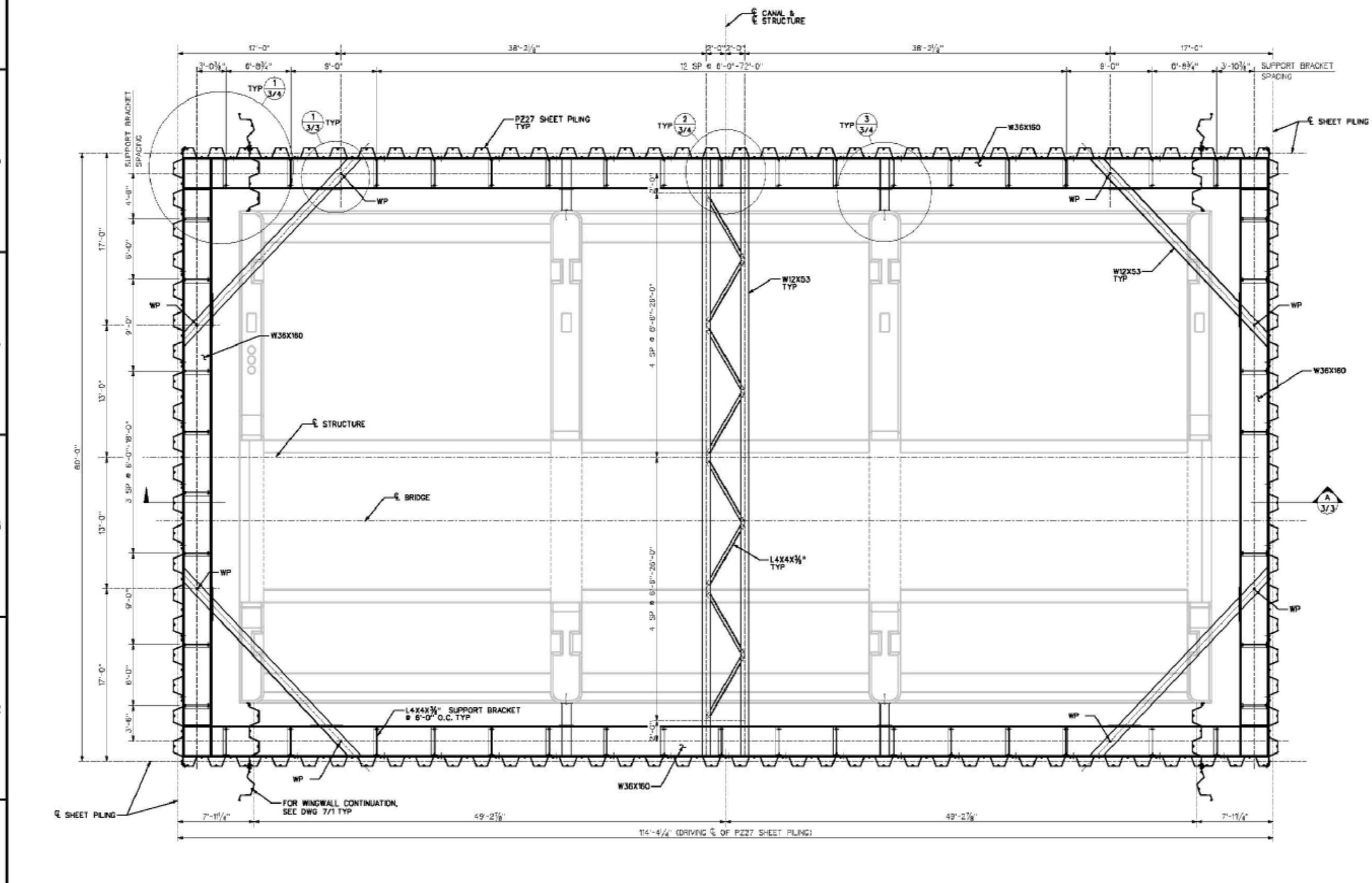
Date: AUGUST 2002

CENTRAL AND SOUTHERN FLORIDA ECOSYSTEM
CRITICAL RESTORATION PROJECT
WESTERN C-11 BASIN PHASE 2
SPILLWAY 381
SITEWORK
FINAL SITE PLAN

DRAWING NO.
2 / 1A

Braced Cofferdam

- Required construction of work platform and diversion channel
- Bottom of foundation approx 20’ below water surface
- Required blasting to get sheets through limestone



COFFERDAM PLAN
SCALE: 1/4"-1'-0"

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JACKSONVILLE, FLORIDA

HDR ENGINEERING, INC.
2502 N. WEST SHORE BLVD.
SUITE 250
TAMPA, FL 33607

D.O. FILE NO. 402-38,333

CENTRAL AND SOUTHERN FLORIDA ECOSYSTEM
CRITICAL RESTORATION PROJECT
WESTERN C-11 BASIN PHASE 2
SPILLWAY 381
COFFERDAM
COFFERDAM PLAN

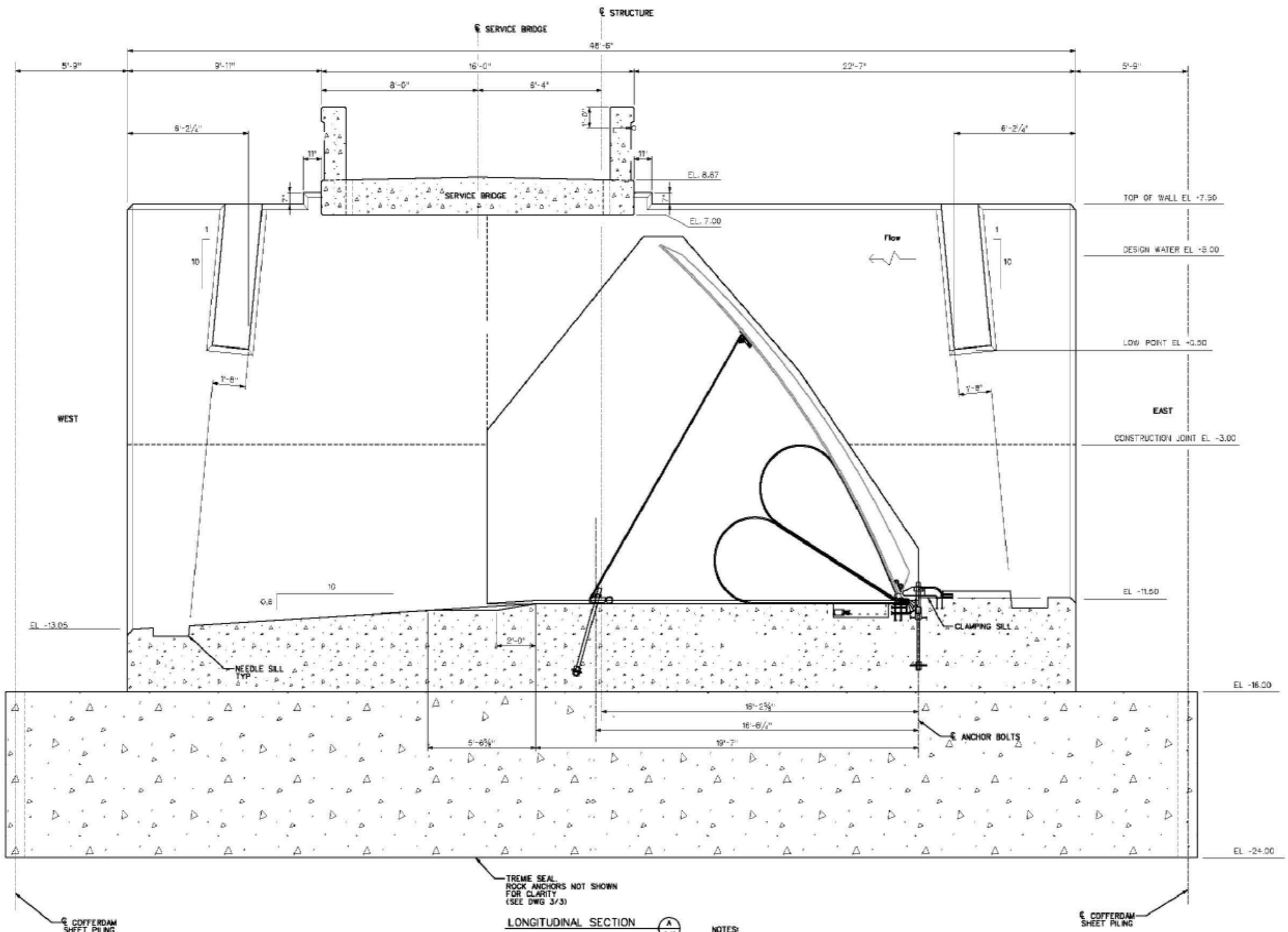
DRAWING NO.
3 /1

Tremie Seal

- 8’ thick concrete seal placed by tremie to allow construction in dry
- Rock anchors used to reduce thickness of tremie and to anchor spillway structure

Spillway Structure

- 101’-6” long X 48’-6” wide overall
- Exterior walls 2’-6” thick
- Interior walls 3’-3” thick
- Walls designed to allow dewatering of any bay
- Foundation 3’-0” to 4’-6” thick
- Integral flat slab bridge helps to brace walls



LONGITUDINAL SECTION (A 4/1)

NOTES:

1. THE HORIZONTAL CONCRETE CLAMPING SURFACE EXTENDING 7" DOWNSTREAM OF MAIN ANCHOR BOLT CENTERLINE AND 8" UPSTREAM OF MAIN ANCHOR BOLT CENTERLINE SHOULD BE LEVEL WITHIN ¼" FROM WALL TO WALL.
2. ALL DIMENSIONS TO WITHIN +-⅛" OF TRUE POSITION.
3. ANCHOR BOLTS TO BE PLUMB AND PERPENDICULAR TO EACH ABUTMENT PLATE +-1/16 ".
4. COORDINATE THE PLACEMENT OF ALL ANCHOR BOLTS AND EMBEDED PLATES WITH O.H.L.
5. FOR GATE DETAILS, SEE DRAWING NO'S. 6/1 THRU 6/3.
6. FOR REINFORCING DETAILS, SEE DRAWING NO'S. 5/1 THRU 5/6.

SCALE: ½" = 1'-0"

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Jacksonville District

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JACKSONVILLE, FLORIDA

HDR ENGINEERING, INC.
2202 N. WEST SHORE BLVD.
SUITE 250
TAMPA, FL 33607
CA 4213

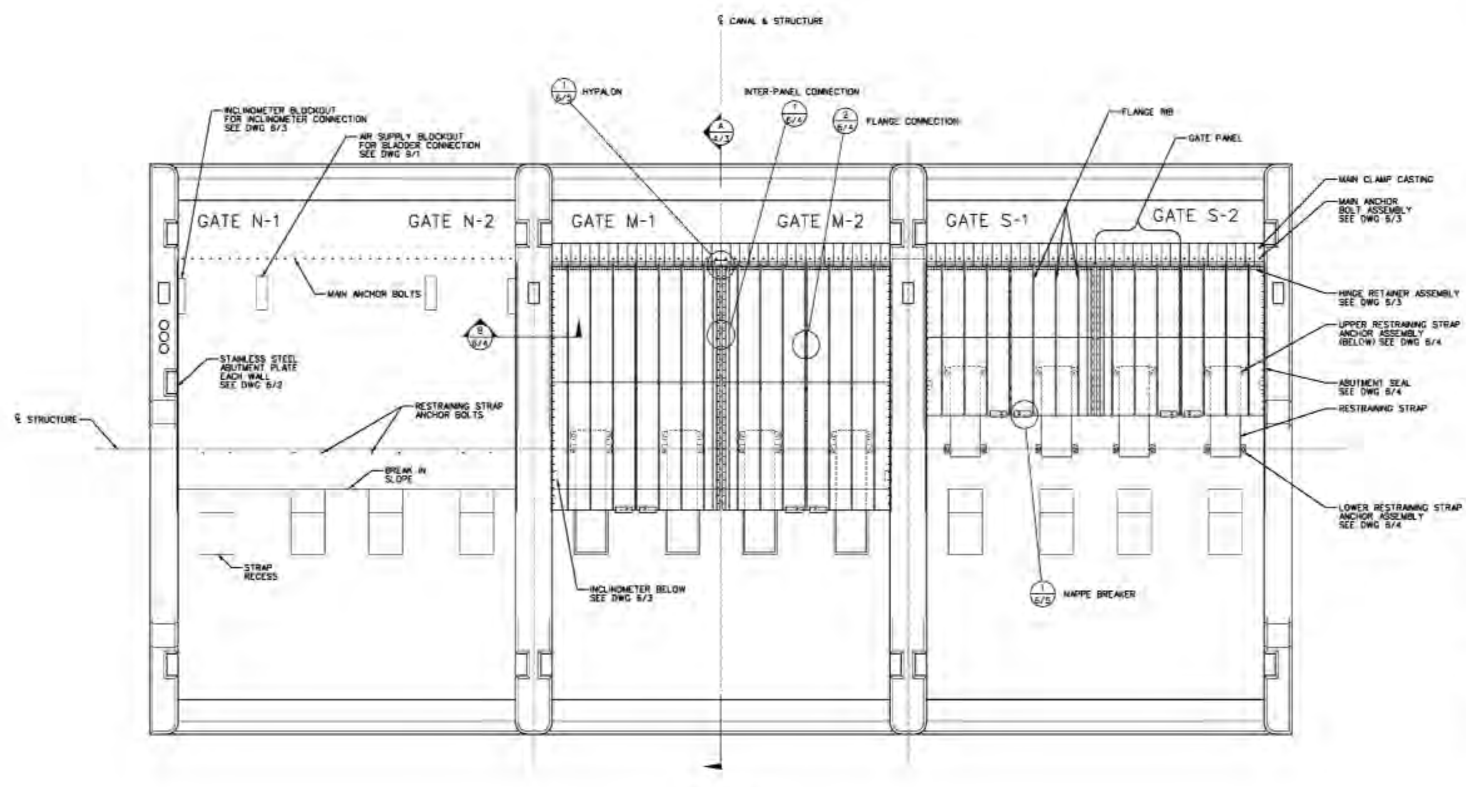
Designed by: R. WALTER
Date: AUG 2002
D.O. FILE NO. 402-38,333

CENTRAL AND SOUTHERN FLORIDA ECOSYSTEM CRITICAL RESTORATION PROJECT
WESTERN C-11 BASIN PHASE 2
SPILLWAY 381
CONCRETE
LONGITUDINAL SECTION

DRAWING NO.
4 /3

Design Criteria

- Structure designed to allow for dewatering of one bay at a time for maintenance
- Structure designed for a maximum water elevation of 5.00
- Designed for reverse head condition.
- Rock anchors designed for maximum overturning and sliding stability.



PLAN VIEW

NOTES:

1. BRIDGE AND HAND RAILS NOT SHOWN FOR CLARITY.
2. ALL LABELED ITEMS ARE TYPICAL UNLESS OTHERWISE STATED.
3. NORTH BAY SHOWN PRIOR TO GATE INSTALLATION.
4. MIDDLE BAY SHOWN WITH GATES IN THE DOWN POSITION.
5. SOUTH BAY SHOWN WITH GATES IN THE UP POSITION.
6. EACH GATE CONSISTS OF 2 MIRRORED GATE PANELS. FOR ASSEMBLY PURPOSES PANELS WILL BE PAIR STAMPED PRIOR TO SHIPPING.

SCALE: 1/2" = 1'-0"

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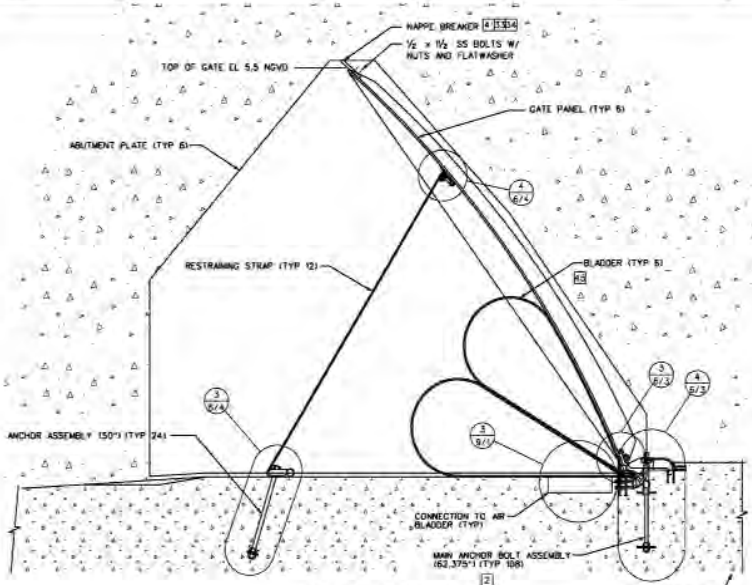
JACKSONVILLE, FLORIDA

HDR ENGINEERING, INC.
2202 N. WEST SHORE BLVD.
SUITE 250
TAMPA, FL 33607
CA 4213

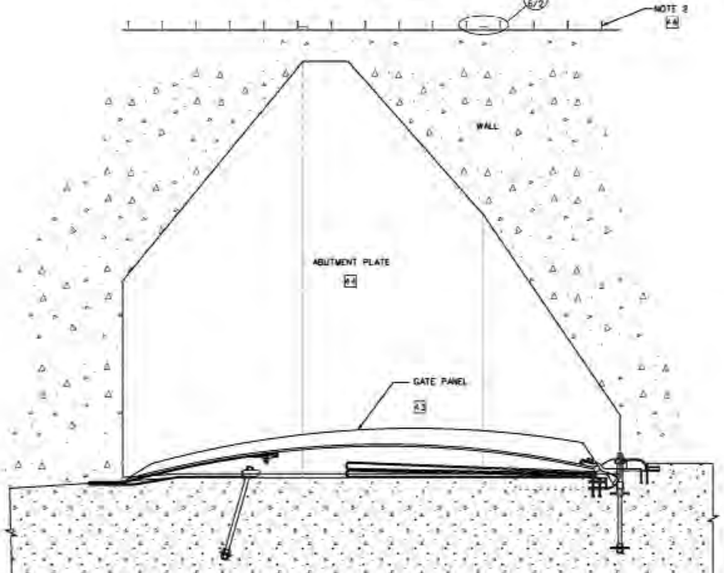
Date: DECEMBER 2002

CENTRAL AND SOUTHERN FLORIDA ECOSYSTEM
CRITICAL RESTORATION PROJECT
WESTERN C-11 BASIN PHASE 2
SPILLWAY 381
OHI BOTTOM HINGED PNEUMATIC GATE
GATE PLAN

DRAWING NO.
6 /1



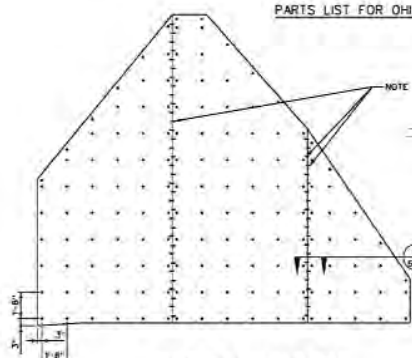
GATE UP ELEVATION
SCALE: 1/2"=1'-0"



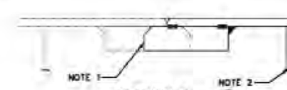
GATE DOWN ELEVATION
SCALE: 1/2"=1'-0"

ITEM	ANCHOR ASSEMBLY & CLAMP	SHEET	WEIGHT	QUANTITY
1	2.5" UNC BRONZE NUT	6/3	6	108
2	MAIN ANCHOR BOLT ASSEMBLIES (62.375")	6/3	103	108
3	20' 304 SS 4" CLAMPING SILL PLATE	6/3	188	3
4	10' 304 SS 4" CLAMPING SILL PLATE	6/3	94	3
5	20' 304 SS 9" BY 6" BLADDER WEDGE PLATE	6/3	715	3
6	10' 304 SS 9" BY 6" BLADDER WEDGE PLATE	6/3	357	3
7	MAIN CLAMP CASTINGS 6" WEDGE 45 7/64	6/3	230	108
8	HINGE FLAP (APP. 15' X 14.75" X 1.5")	6/3	223	6
9	BLADDER WEDGE AREA CONCRETE SHAPING FORMS	6/3	10	3
	RESTRAINING STRAP ANCHOR & CLAMPS			
10	2.0" UNC X 50" 304 SS RS ANCHOR ASSEMBLIES	6/4	64	24
11	2.0" UNC SS NUTS	6/4		24
12	2.0" SS FLAT WASHERS	6/4		24
13	2.0" UNC X 5" LONG BOLT (GATE)	6/4		12
14	36" X 9.5" X 3" RS CLAMP A36 (LOWER)	6/4	290	12
15	36" X 9.5" X 3" RS CLAMP A36 (UPPER)	6/4	290	12
16	NYLON ROD 1 5/8" X 24"	6/4		24
17	RESTRAINING STRAPS (APP 16' X 24" X .75")	6/4	137	12
	AIR SUPPLY CONNECTIONS			
18	1" BRASS BLADDER FITTING	9/1		6
19	1" NPT 250 PSIG CAST BRASS ELBOW	9/1		6
20	1" NPT X1" BRASS HOSE BARB	9/1		6
21	3/4"-1.5" SS HOSE SCREW CLAMPS	9/1		24
22	1" 16M3K-XTF 3,000 PSIG GATES HOSE	9/1		20
23	1" NPT X 1" SS HOSE BARB	9/1		6
24	3.0" X 1.0" NPT SS BUSHING	9/1		6
25	3.0" SS WELD BY NPT ELBOW	9/1		6
	GATES			
26	5/8" SS UNC NUTS FOR INTER PANEL SEALS	6/3		360
27	5/8" SS UNC FLAT WASHERS FOR INTER PANEL SEALS	6/3		360
28	1.25" UNC SS NUTS FOR HINGE RETAINERS	6/3		305
29	1.25" SS UNC FLAT WASHERS FOR HINGE RETAINERS	6/3		305
30	1.25" UNC X 4.0" LONG SS BOLTS FOR FLNG RIB	6/4		138
31	1.25" UNC SS NUTS FOR FLANGE RIB	6/4		138
32	1.25" SS FLAT WASHERS FOR FLANGE RIB	6/4		138
33	1/2" X 1.5" UNC SS HEX BOLTS FOR NAPPE BRKR	6/2		48
34	1/2" SS FLAT WASHERS FOR NAPPE BREAKER	6/2		48
35	3/8" UNC X 1.5" LONG ALLAN SCREWS	6/3		14
36	INCLINOMETER	6/3	3	6
37	SEAL RETAINER (SETS)	6/3	54	12
38	ABUTMENT SEALS (APP. 22' X 7.25" X 1.1")	6/4	83	6
39	INTER-PANEL SEALS (APP. 22' X 8" X .75")	6/4	63	3
40	HYPALON PIECES (12" X 36")	6/5	2	12
41	NAPPE BREAKER (APP 18" X 6" X 1.5")	6/2	7	12
42	HINGE RETAINER (APP. 24" X 1.25" X 3")	6/5	25	48
43	GATE PANELS (6 SETS)	6/2	8950 (EACH)	12
	ABUTMENTS			
44	ABUTMENT PLATES (6 SETS OF 3 PIECES)	6/2	3031 (EACH)	6
	US: 470; M: 1381; DS: 1180			
	BLADDERS			
45	BLADDERS (APP. 15' X 11' X 4")	6/2	2540	6
	COMPRESSOR PACKAGE			
46	COMPRESSOR: ROTARY IR UP25-125-BM	8/2	1203	2
47	STARTUP KIT			2
48	PRE-FILTER: IR HE 375	9/2		1
49	IR HE 375 FILTER ELEMENTS	9/2		1
50	DRYER: IR TS250	8/2	310	1
51	ACCUMULATOR TANK: 240 GALLON	8/2	520	1
52	AUTOMATIC DRAIN VALVE EDV 2000	9/2		1
53	2" FULL PORT BRONZE SOFT SEAT BALL CHECK VALVE			1
	MISCELLANEOUS			
54	AIR CONTROL CABINET (PAINTED) (NOTE 3)	9/3	880	1
55	3/4" X 4" ADHESIVE ANCHOR	9/3		4
56	MUFFLER	9/2	26	1

PARTS LIST FOR OHIBOTTOM HINGED PNEUMATIC GATE



ABUTMENT PLATE STUD DETAIL
SCALE: NTS



SECTION A
SCALE: NTS

NOTES:

1. ABUTMENT PLATE SECTIONS TO BE SHIPPED WITH WELD LUGS ON STAGGERED 12" CENTERS. FIELD WELD AND GRIND PER OHISPECIFICATION.
2. NELSON STUDS PRE-WELDED TO ABUTMENT PLATES.
3. SEE DWG 9/3 FOR AIR CONTROL CABINET CONTENTS AND DETAILS.

US Army Corps of Engineers
Jacksonville District

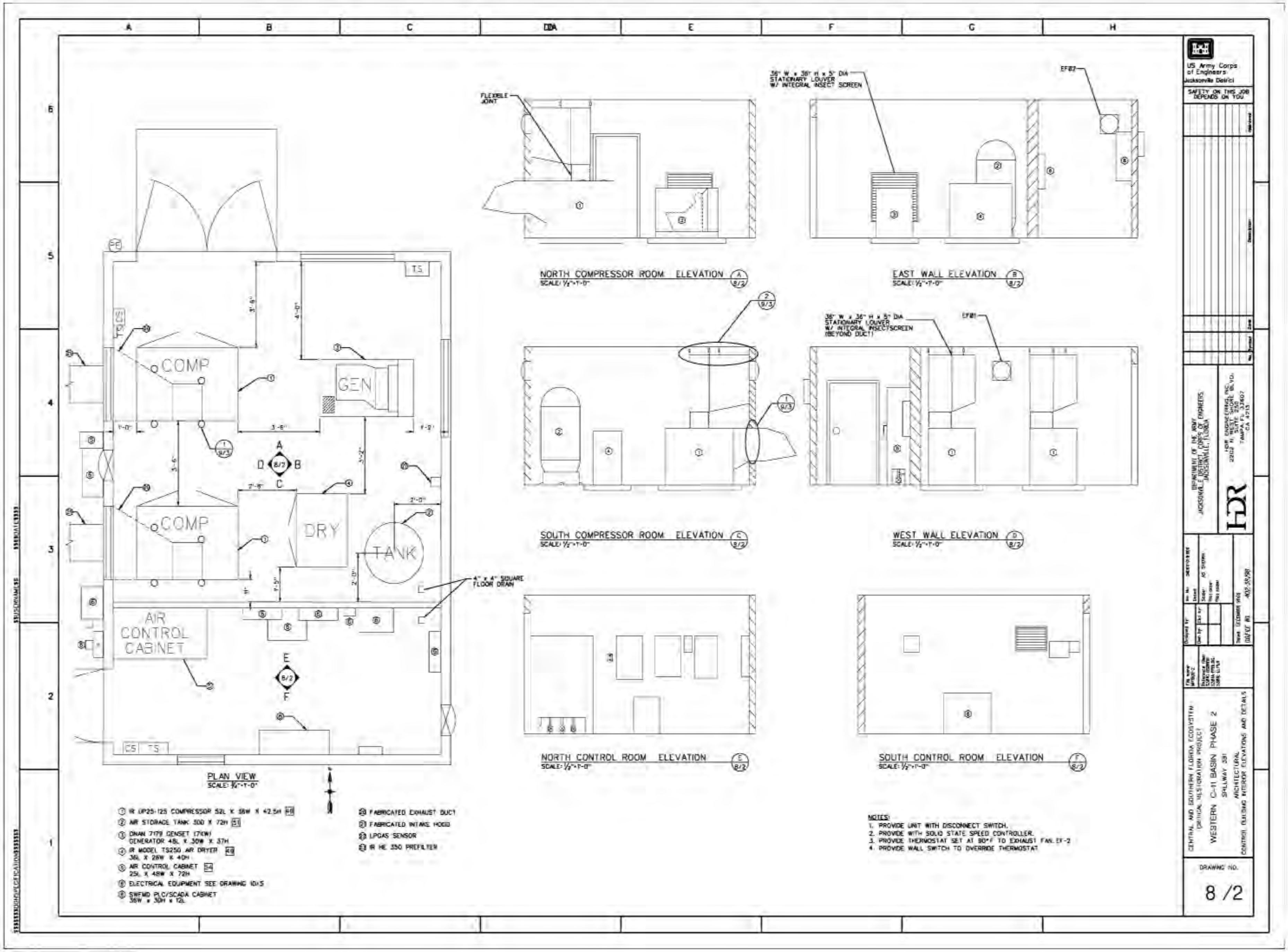
SAFETY ON THIS JOB DEPENDS ON YOU

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

HDR ENGINEERING, INC.
2202 N. WEST SHORE BLVD.
SUITE 250
TAMPA, FL 33607
CA 4213

CENTRAL AND SOUTHERN FLORIDA ECOSYSTEM
CRITICAL RESTORATION PROJECT
WESTERN C-11 BASIN PHASE 2
SPILLWAY 381
OHI BOTTOM HINGED PNEUMATIC GATE
GATE DETAILS - 1 OF 4

DRAWING NO.
6 /2



NORTH COMPRESSOR ROOM ELEVATION
SCALE: 1/2"=1'-0"
FLEXIBLE JOINT
EAST WALL ELEVATION
SCALE: 1/2"=1'-0"
36" W x 36" H x 5" DIA STATIONARY LOUVER W/ INTEGRAL INSECT SCREEN
EF#2
SOUTH COMPRESSOR ROOM ELEVATION
SCALE: 1/2"=1'-0"
WEST WALL ELEVATION
SCALE: 1/2"=1'-0"
36" W x 36" H x 5" DIA STATIONARY LOUVER W/ INTEGRAL INSECTSCREEN (BEYOND DUCT)
EF#1
NORTH CONTROL ROOM ELEVATION
SCALE: 1/2"=1'-0"
SOUTH CONTROL ROOM ELEVATION
SCALE: 1/2"=1'-0"
COMP
GEN
COMP
DRY
TANK
AIR CONTROL CABINET
4" x 4" SQUARE FLOOR DRAIN
PLAN VIEW
SCALE: 3/8"=1'-0"
① IR UP25-125 COMPRESSOR 52L X 36W X 42.5H 48
② AIR STORAGE TANK 300 X 72H 51
③ ONAN 7179 GENSET (7KW) GENERATOR 48L X 30W X 37H
④ IR MODEL TS250 AIR DRYER 49 36L X 26W X 40H
⑤ AIR CONTROL CABINET 54 25L X 48W X 72H
⑥ ELECTRICAL EQUIPMENT SEE DRAWING 10/5
⑧ SWFMD PLC/SCADA CABINET 36W x 30H x 12L
⑳ FABRICATED EXHAUST DUCT
㉑ FABRICATED INTAKE HOOD
㉒ LPGAS SENSOR
㉓ IR HE 350 PREFILTER
NOTES:
1. PROVIDE UNIT WITH DISCONNECT SWITCH.
2. PROVIDE WITH SOLID STATE SPEED CONTROLLER.
3. PROVIDE THERMOSTAT SET AT 90°F TO EXHAUST FAN EF-2
4. PROVIDE WALL SWITCH TO OVERRIDE THERMOSTAT
US Army Corps of Engineers Jacksonville District
SAFETY ON THIS JOB DEPENDS ON YOU
DEPARTMENT OF THE ARMY JACKSONVILLE DISTRICT CORPS OF ENGINEERS JACKSONVILLE, FLORIDA
HDR ENGINEERING, INC. 2202 N. WEST SHORE BLVD. SUITE 250 TAMPA FL 33607
HDR
CENTRAL AND SOUTHERN FLORIDA ECOSYSTEM CRITICAL RESTORATION PROJECT
WESTERN C-11 BASIN PHASE 2
SPILLWAY 381
ARCHITECTURAL
CONTROL BUILDING INTERIOR ELEVATIONS AND DETAILS
DRAWING NO.
8 /2

Construction Photos


Link-Belt
5. 11. 2004 14:18


CHEVROLET
5. 11. 2004 14:03


10. 19. 2004 10:43


10. 19. 2004 10:53


10. 19. 2004 10:52


10. 19. 2004 10:52


3. 9. 2005 11:03


AirCare
IR Ingersoll Rand
AirCare
IR Ingersoll Rand
3. 9. 2005 10:28


Detector
AirCare
Ingersol
3. 9. 2005 10:28


3. 9. 2005 10:23


3. 9. 2005 10:25

Miscellaneous Contract Details

- Local sponsor (SFWMD) requested SST gates and abutment plates to reduce future O&M costs
- Bid Schedule – Fixed cost bid item provided for Obermeyer services and equipment:

  Includes equipment

  Transporting equipment to site

  Providing on-site installation services
- Cost for 6 gates all OHI supplied material ~ $1,000,000
- OHI parts warranty – 2 years

Final Comments

1. Jacksonville's H&H Branch has adopted these structures and proposed them on several future projects

2. Lower profile spillway structure that is mechanically much simpler due to no operating platform and may possibly save money

3. Use of this product successfully resolved a design dilemma for the Jacksonville District

OBERMEYER GATED SPILLWAY S381

Jacksonville District 2005

Video Presentation

Shows several of their installations

Benefits discussed include

- Drop gates without power (during floods)
- Gates can be independently operated
- Does not use hydraulic fluids
- Gates up to 10 meters tall
- Versatile, numerous applications

NDIA Infrastructure Conference

SEISMIC ISOLATION OF MISSION-CRITICAL INFRASTRUCTURE TO RESIST EARTHQUAKE GROUND SHAKING OR EXPLOSION EFFECTS

August 2005
St. Louis, Missouri

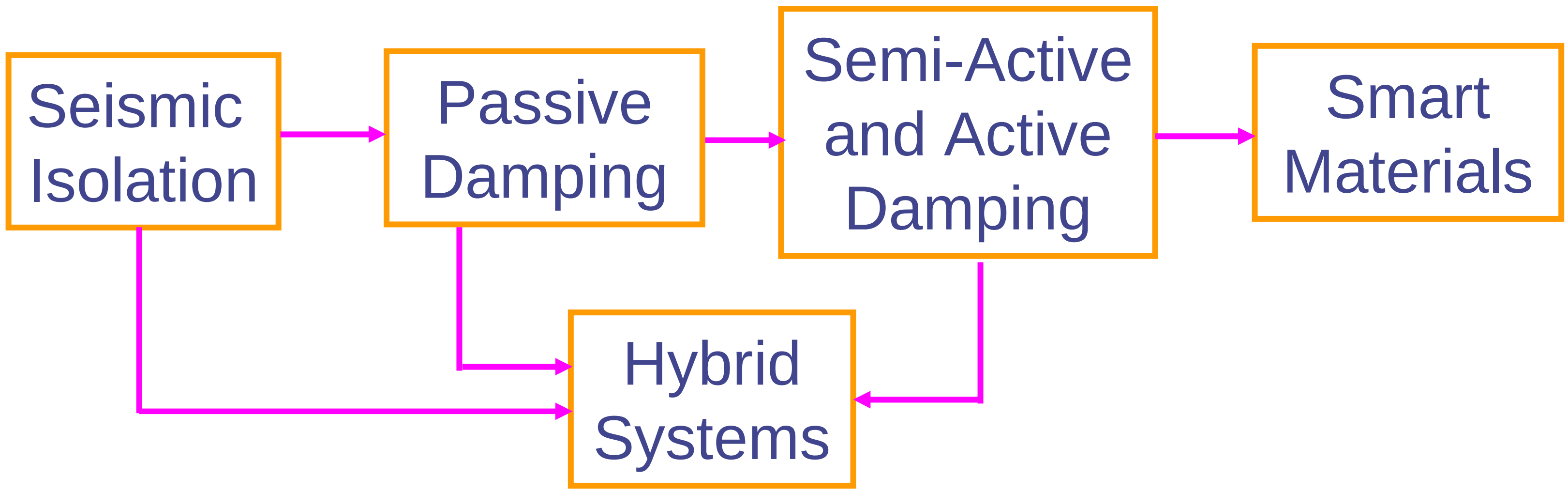
Harold O. Sprague, Jr., P.E.
Black & Veatch Special Projects Corp.
spragueho@bv.com,
913-458-6691
Andrew Whitaker
Michael Constantino
University at Buffalo

building a world of difference™ BLACK & VEATCH

History

- 1906 US Patent - Earthquake Proof Building
  - Jacob Bechtold, Munich
- 1921 Imperial Hotel
  - Frank Lloyd Wright, 1923 Tokyo Earthquake, Insight or Hindsight
- 1960's Cheyenne Mountain
  - USACE & Black & Veatch

Protective systems

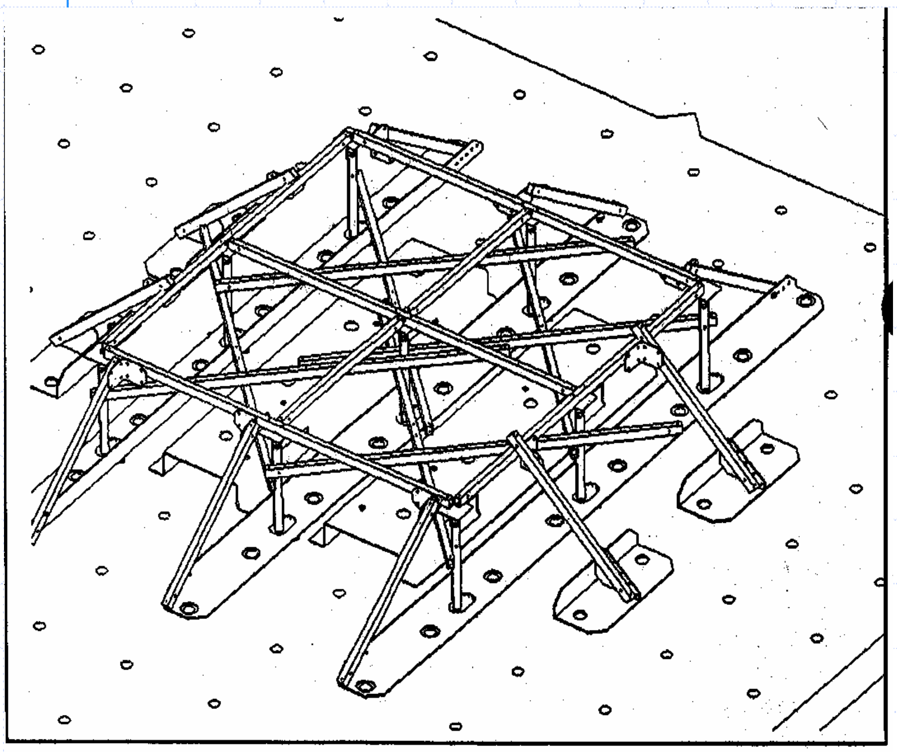


Seismic Isolation	Passive Damping	Semi-Active and Active Damping	Smart Materials
Elastomeric Lead-rubber Sliding (FP)	Metallic Friction Viscoelastic Viscous	Variable Stiffness and Damping Mass Damper	ER Fluid MR Fluid SMA

Blast vs. Seismic - Response and Protection

- Seismic
  - Protect Whole Structure or Nonbuilding Structure
  - Protect Nonstructural Components
    - Data Processing
    - Critical Components,
      - UFC 3-310-04, MC-1, MC-2, NMC
- Blast
  - Protect Nonstructural Components

Demand vs. Capacity NMD Lessons



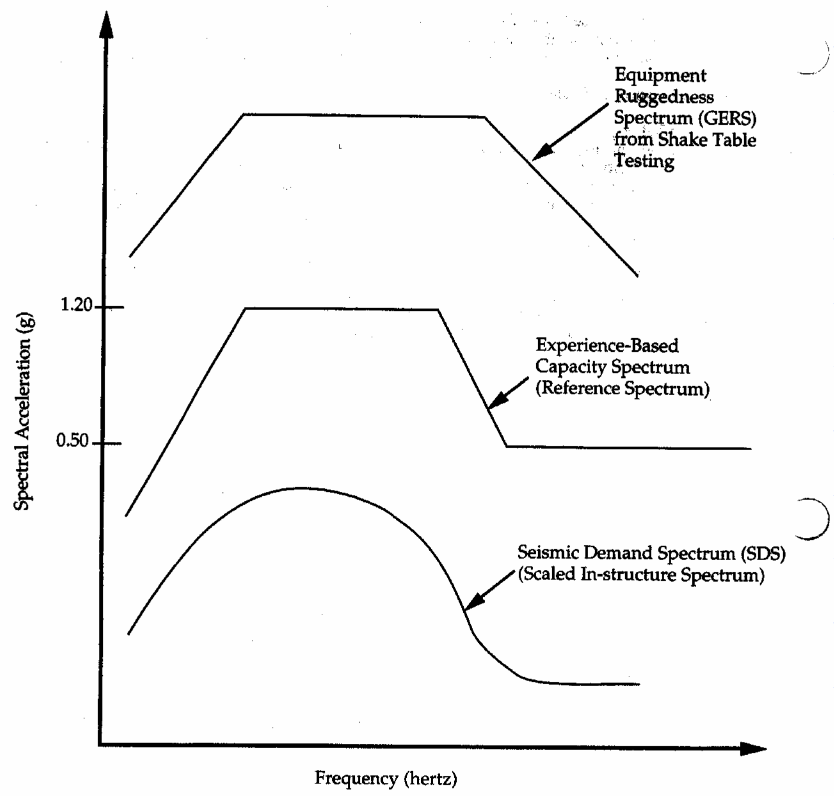


Figure 5.4-1 Comparison of Seismic Capacity Spectrum to Seismic Demand Spectrum

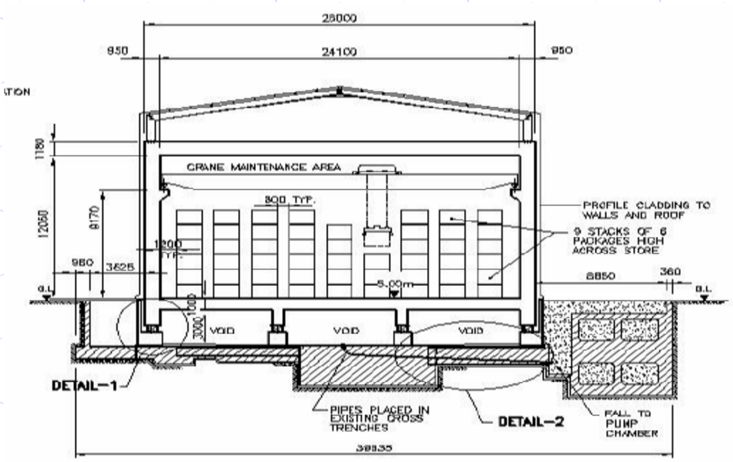
Harold O. Sprague, Jr.
Black & Veatch Special Projects Corp.
August 2005

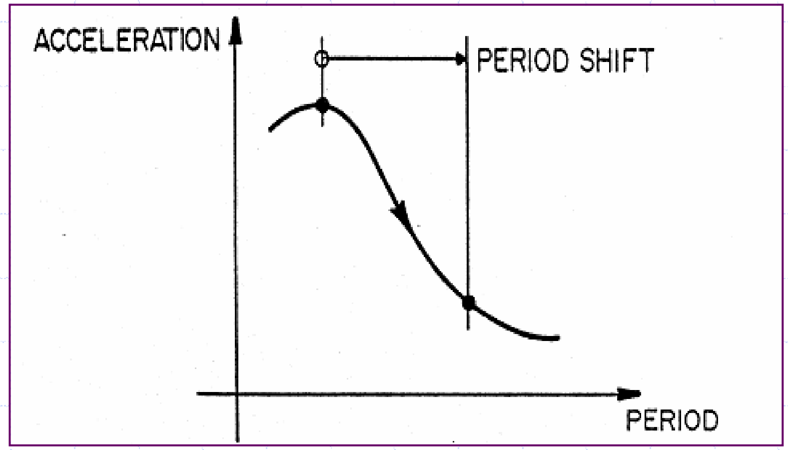
Andrew Whittaker and Michael Constantinou
Department of Civil, Structural and Environmental Engineering
University at Buffalo

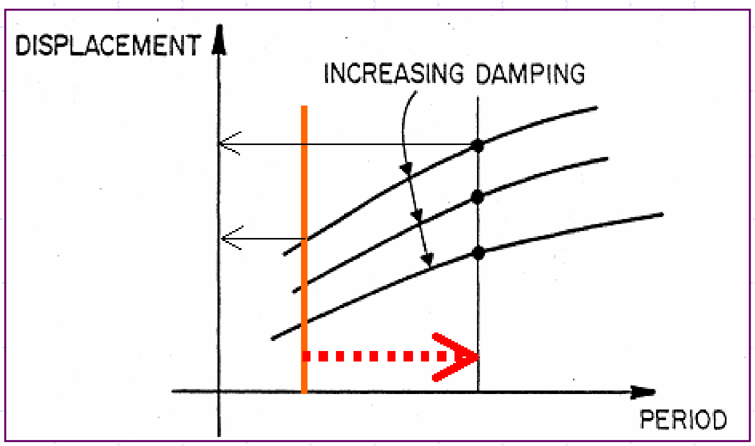
Seismic protective systems

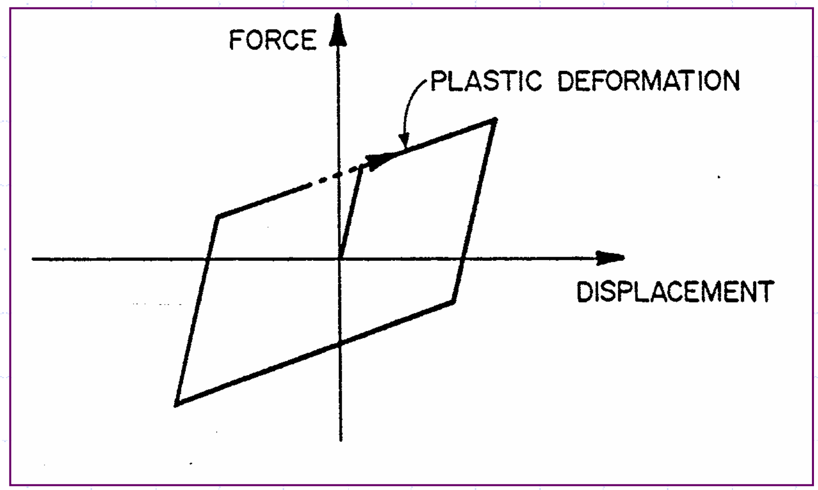
- Seismic isolation
  - Hardware, applications, testing
- Supplemental damping systems
  - Hardware, applications, testing

Principles of seismic isolation









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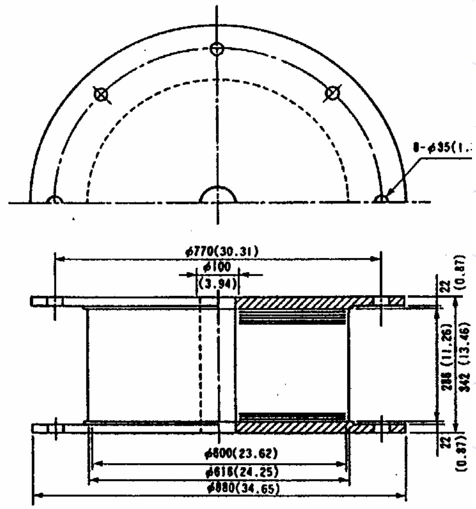
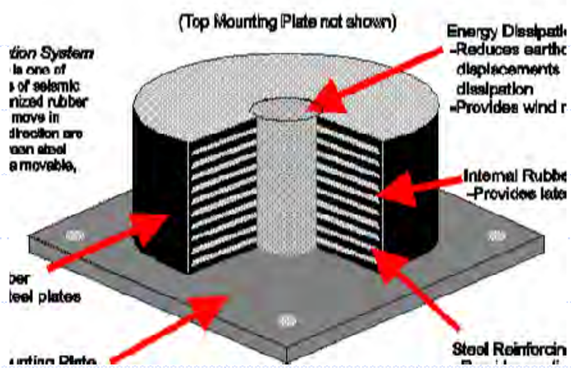
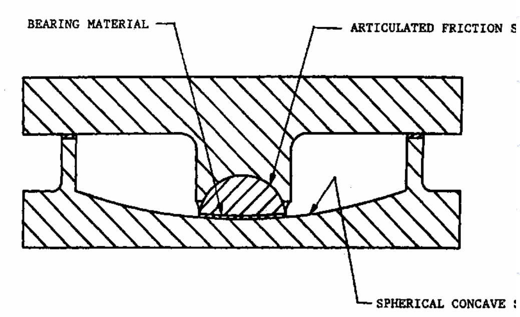
Seismic isolation hardware

- Elastomeric bearings
  - Low-damping rubber
  - High-damping rubber
  - Lead-rubber bearing
- Sliding bearings
  - Friction Pendulum™
  - Flat slider w/restoring force
    - Eradiquake™
  - Flat slider w/yielding devices
    - FIP/Alga







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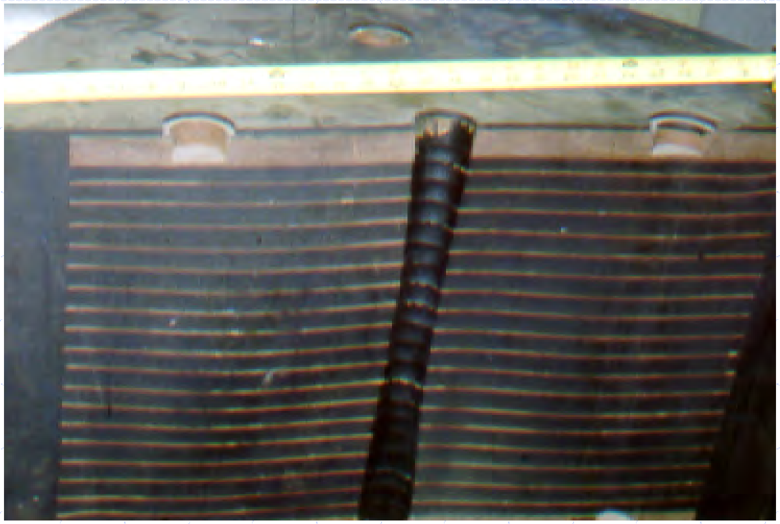
Elastomeric bearings



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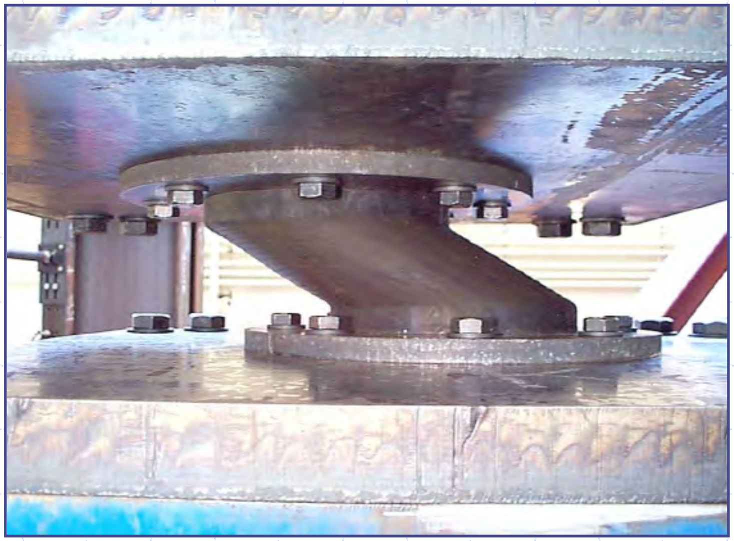
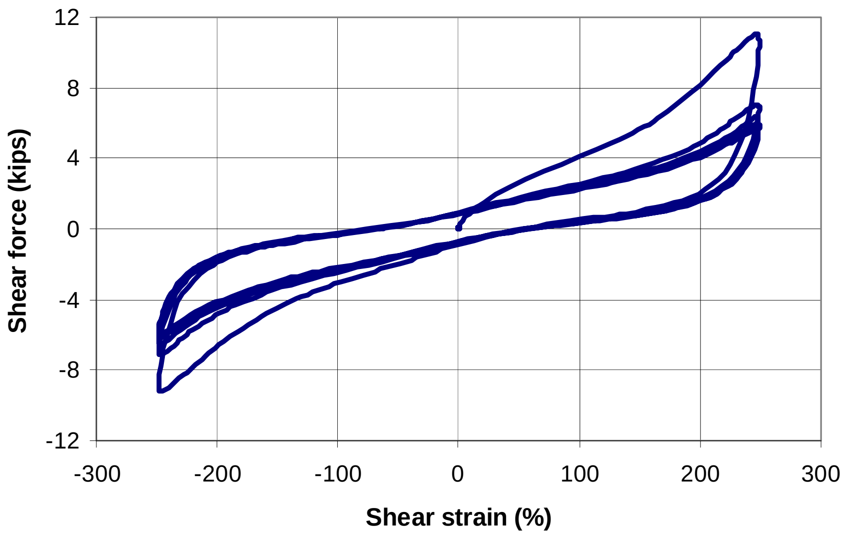
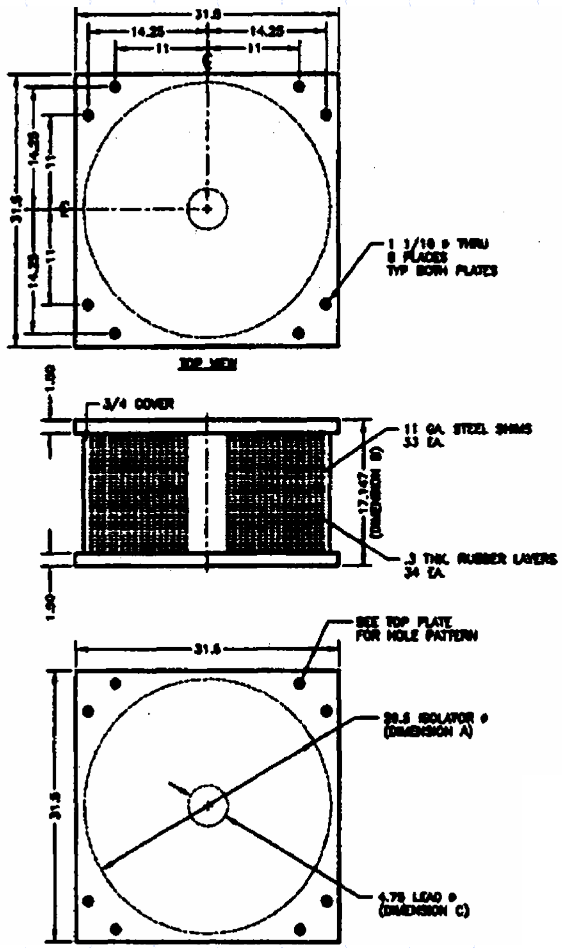
High-damping rubber bearings



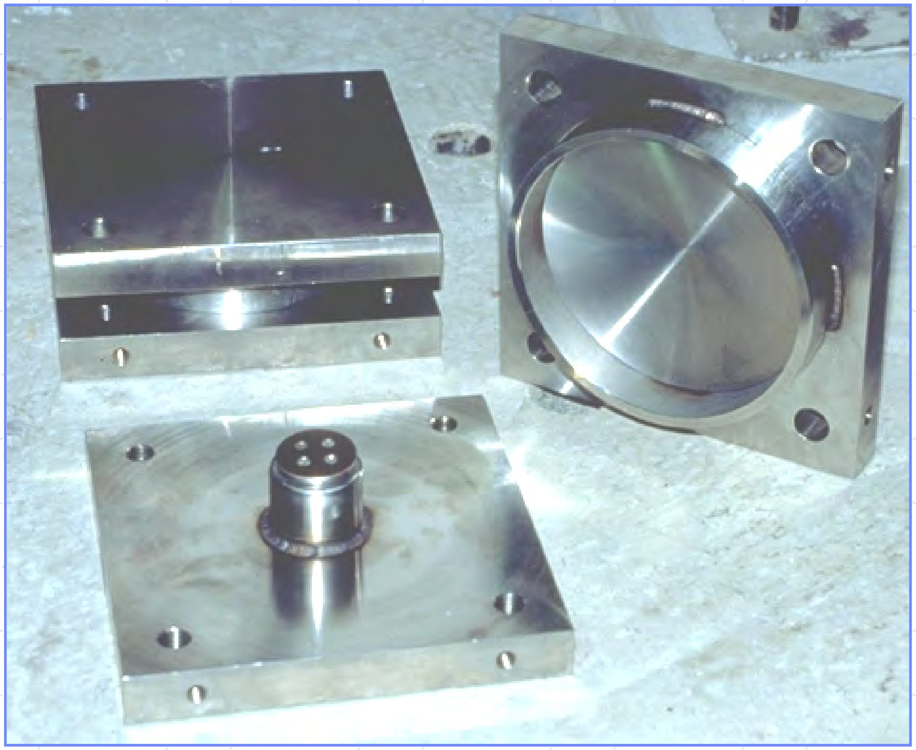


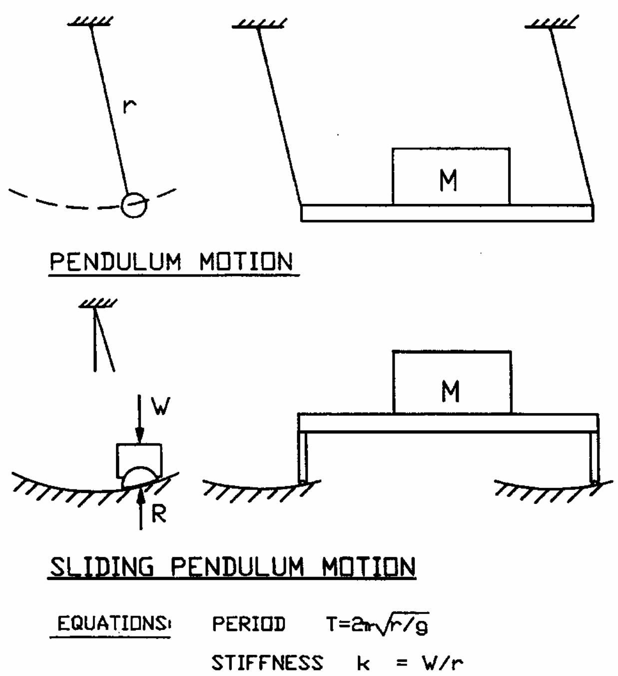
Lead-rubber bearings



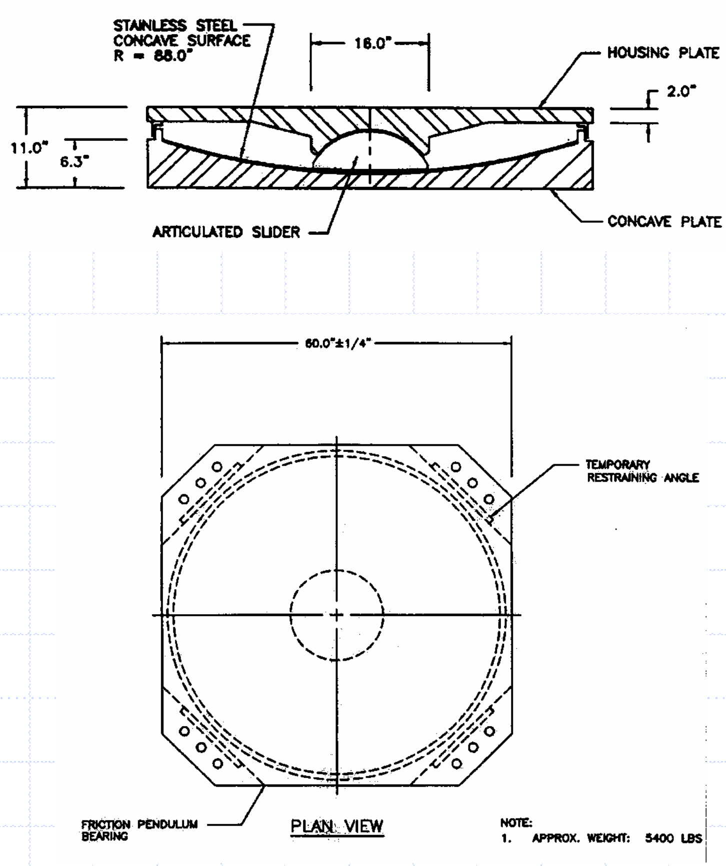
Sliding bearings

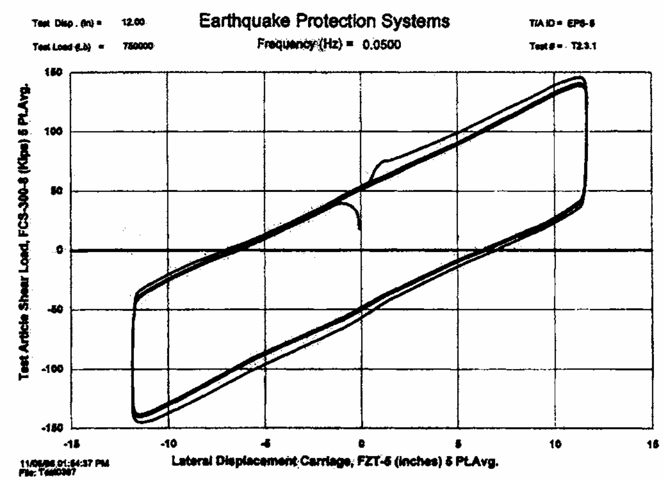
- FP bearing

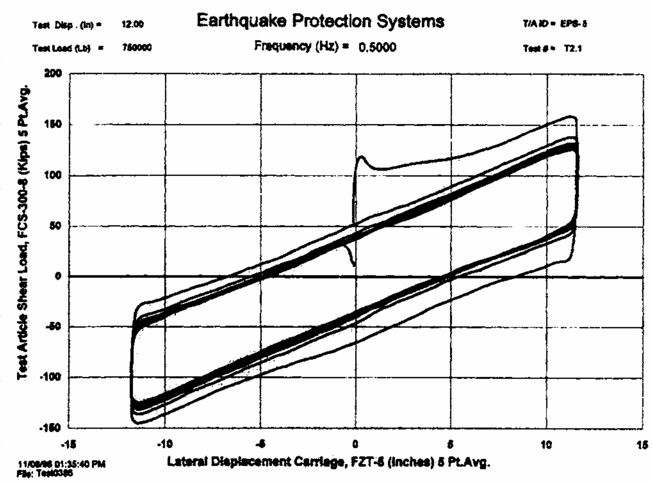




FP bearing







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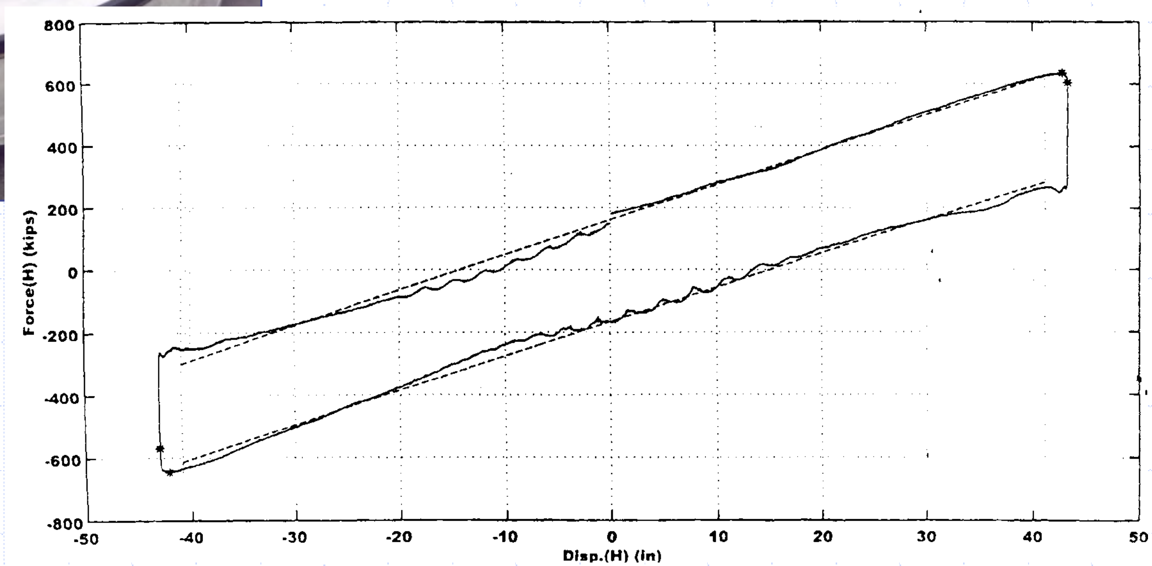
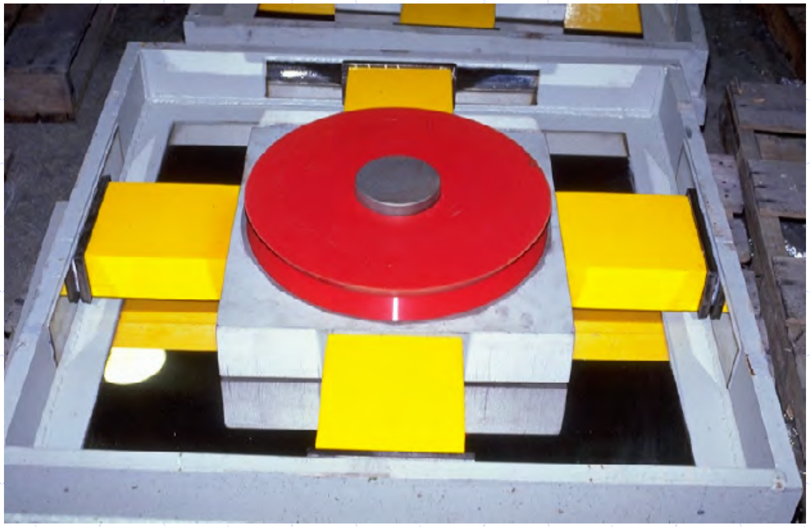
FP bearing


800
600
400
200
0
-200
-400
-600
-800
Force(H) (kips)
-50
-40
-30
-20
-10
0
10
20
30
40
50
Disp.(H) (in)

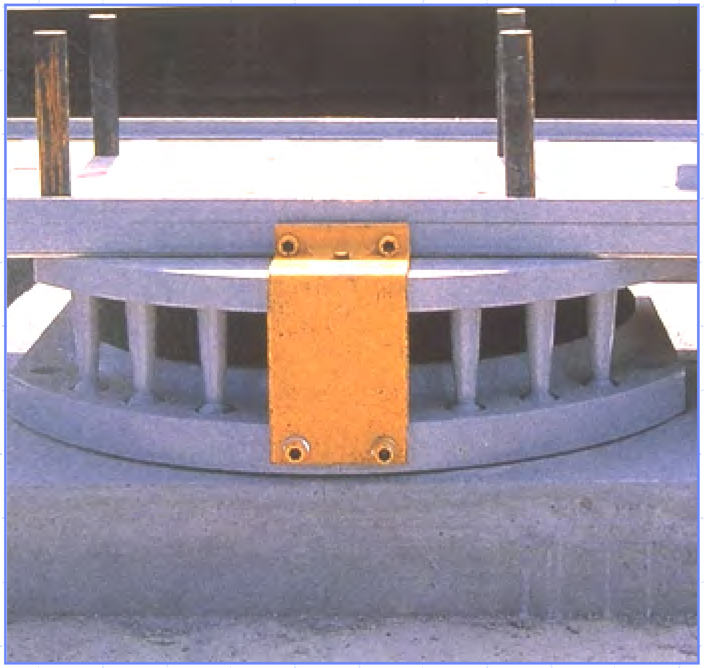
Sliding bearing

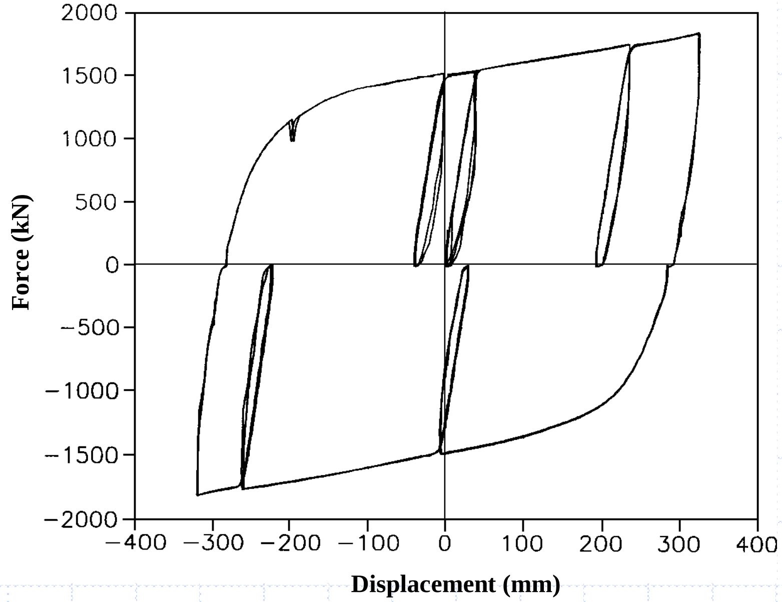
- Flat slider with restoring force
  - Eradiquake™



Sliding bearing

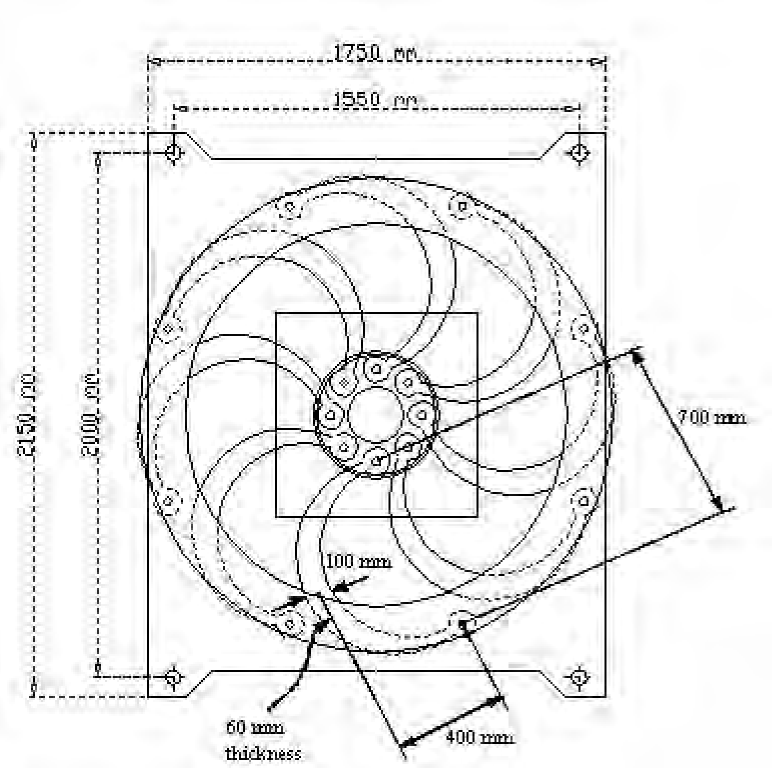
- Flat slider with yielding devices
  - FIP Industriale/Alga
    - Chirag I platform retrofit

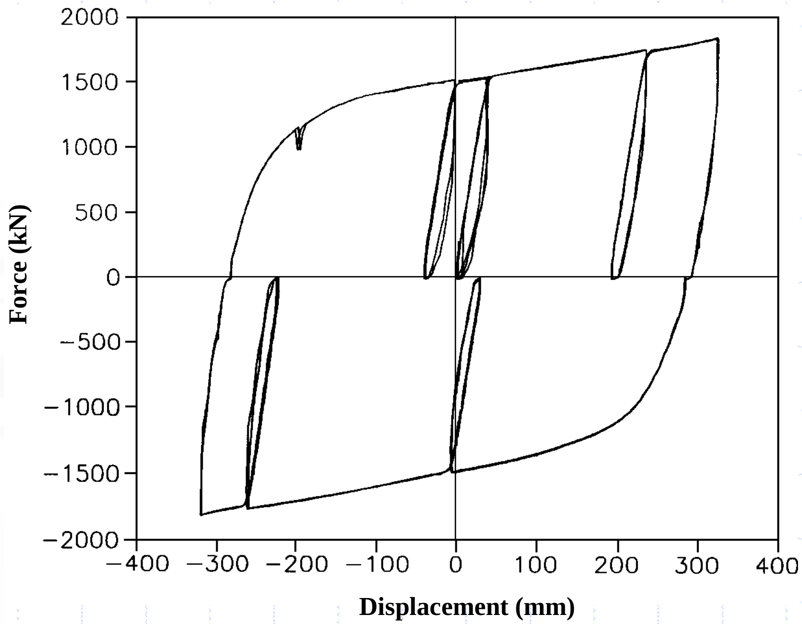




Sliding bearing

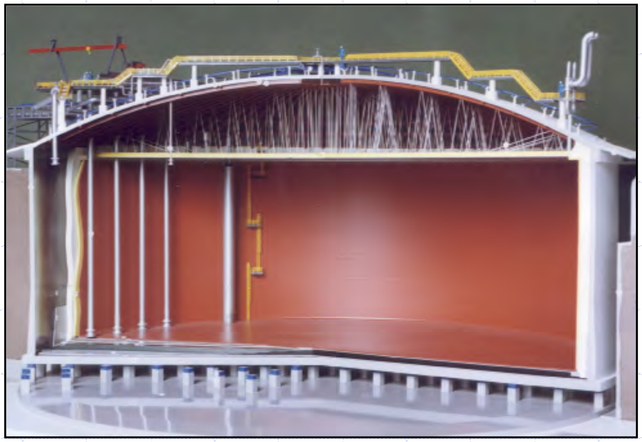
- Flat slider with yielding devices
  - Alga

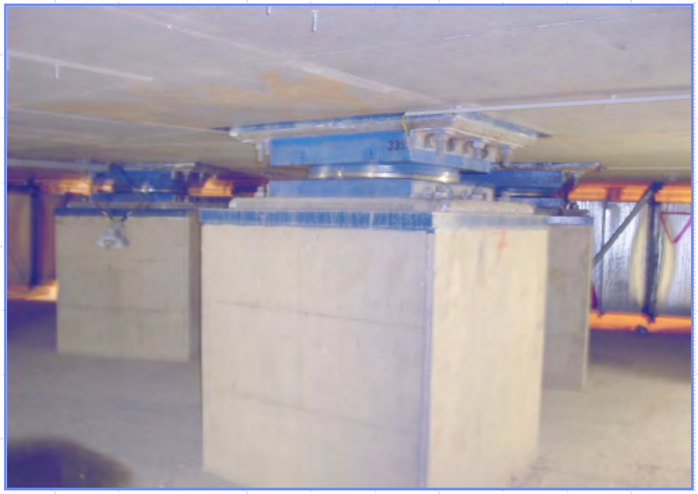




Infrastructure applications

LNG TANKS, REVITHOUSSA, GREECE
FP BEARINGS





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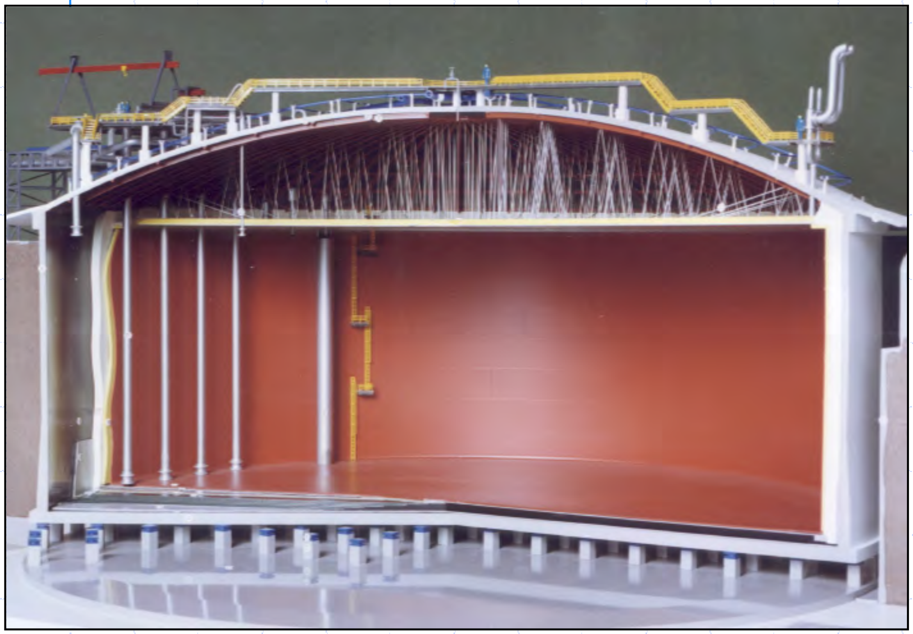
Revithoussa LNG design criteria

- Hazard characterization
  - SSE: 10,000 year return period
- Performance criteria for Cat. 1 components
  - Inner and outer tanks
    - Safety functions operational during and after SSE
    - No loss of structural integrity/damage during and after SSE
- Computer codes
  - ABAQUS, ANSYS, DYNA-3D, 3D-BASIS
- Modeling of isolation components
  - Per 1991 UBC but bilinear models used
- Bounding analysis to capture effects of variations in isolator properties

Revithoussa construction details

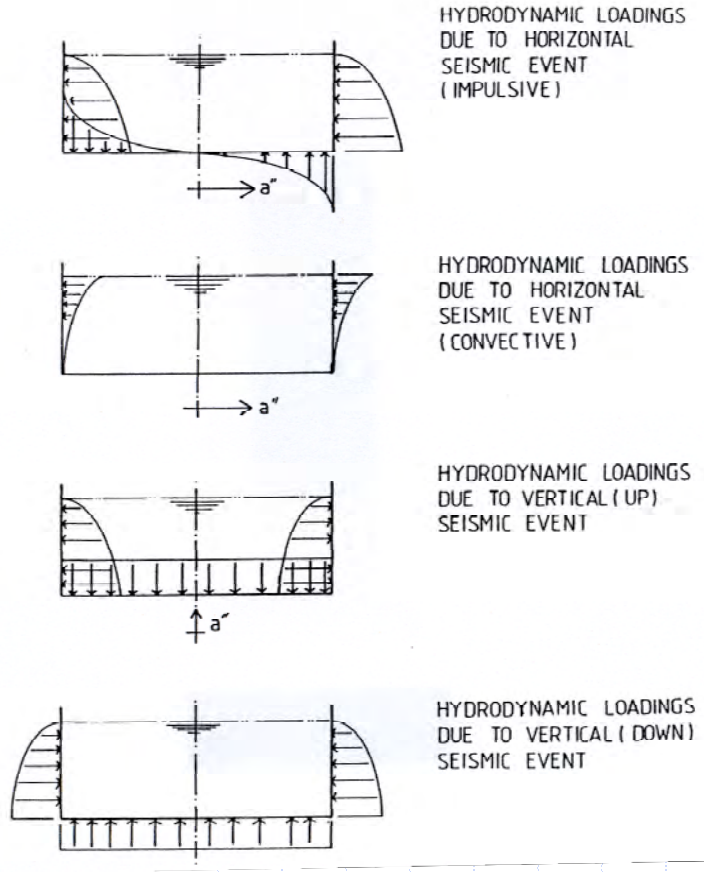


- 65,000 m^3 (17 million gal) capacity
- 35 m (115 ft) high
- 9% nickel inner tank
  - Unanchored tank
- P_s_c outer tank
- 1-m (39 in) thick rc base
- Underground construction for safety reasons
- FP bearings

Infrastructure applications

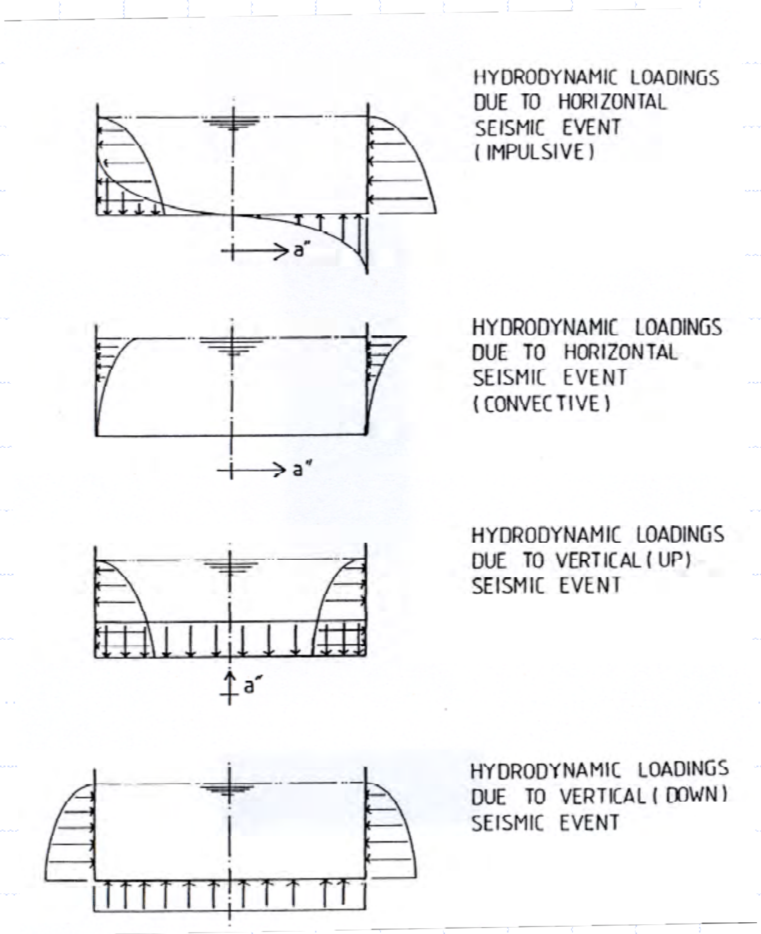
LNG TANKS, INCHON, KOREA
ELASTOMERIC BEARINGS

Isolation of LNG tank facilities



- Hydrostatic and hydrodynamic loadings cause shell hoop tension
- Impulsive and convective liquid loading cause shell compression in the vertical direction
- Use of modification factors (R-factors) for shell hoop stress (e.g., API 620 utilizes a value 2.0) virtually guarantees shell elastoplastic buckling (elephant's foot buckling)

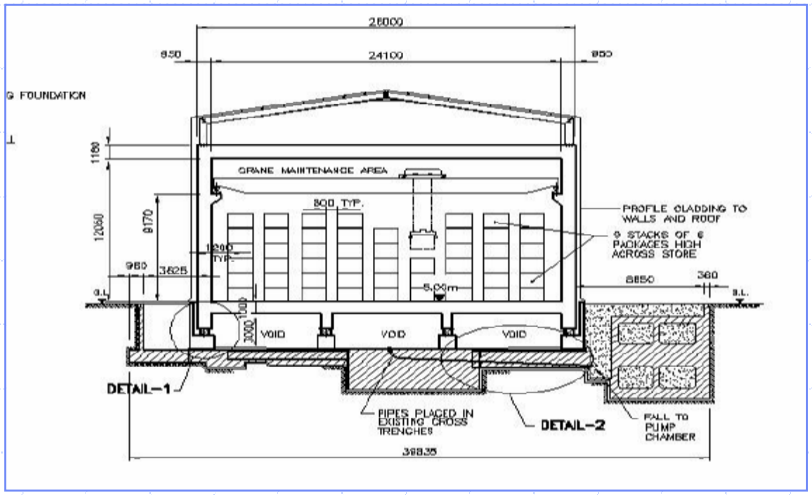
Isolation of LNG tank facilities

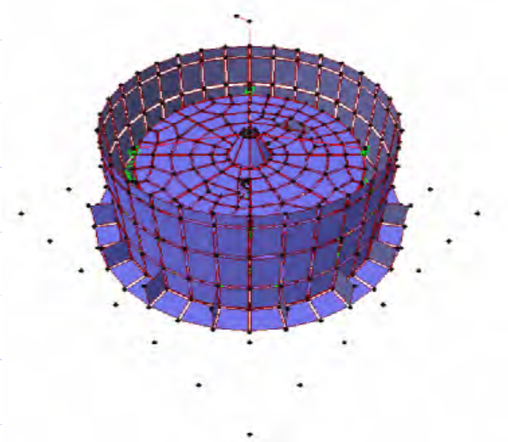


- LNG tanks are tested by filling with water. Since the density of water is twice that of LNG, tanks have additional shell thickness and thus an ability to resist modest earthquake forces
- Seismic isolation permits the use of *standard* LNG tank in regions of high seismicity without the need to anchor the tank or to change the diameter-to-height ratio

Infrastructure applications

ILWS, HUNTERSTON, UK
FP or LEAD-RUBBER BEARINGS





RADAR FACILITY, ALASKA
FP BEARINGS and VDDs

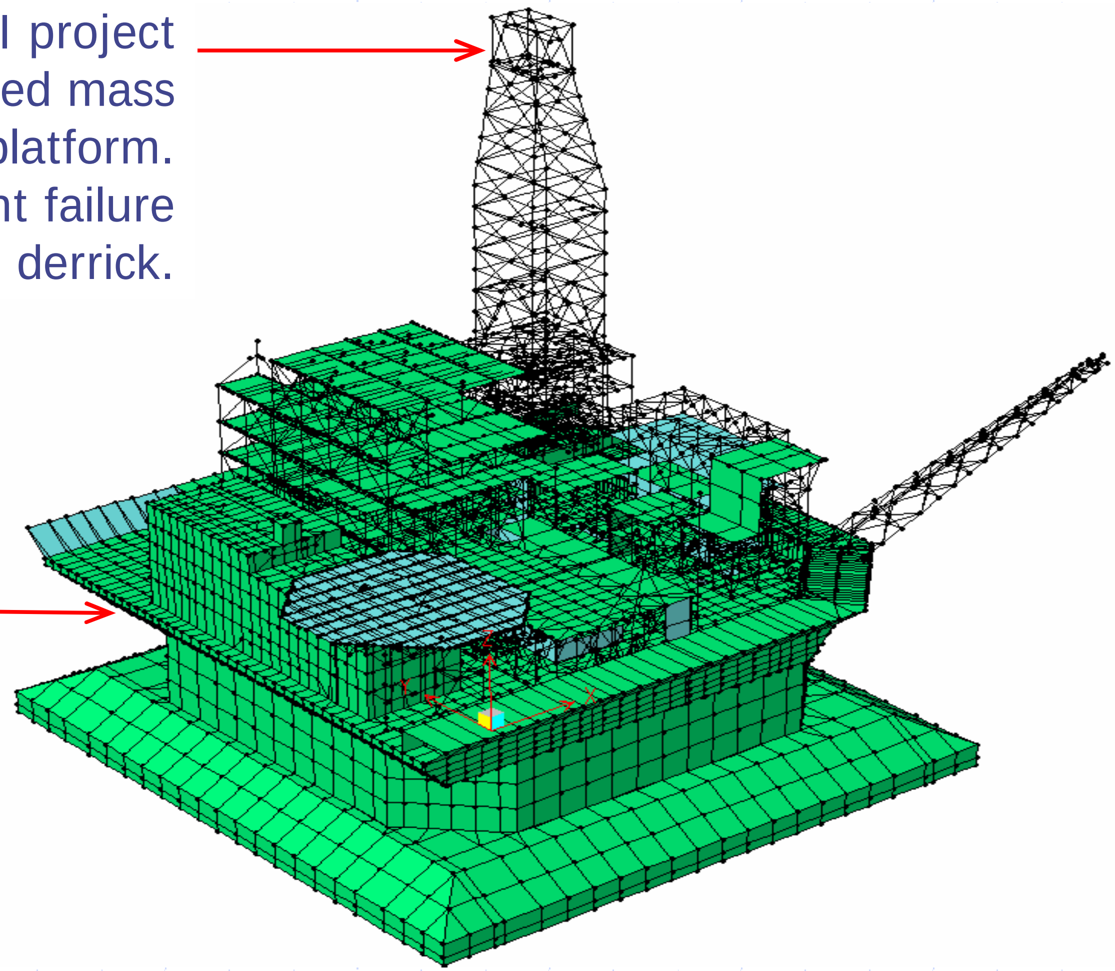
Sakhalin I Orlan platform

SAKHALIN ISLAND, RUSSIA

OFFSHORE GAS PLATFORM WITH CONCRETE GRAVITY BASE

Sakhalin I Orlan platform

Sakhalin I project
Location of tuned mass damper in Orlan platform.
Goal is to prevent failure of members in derrick.



Sakhalin II project.
Location of seismic isolation system in Piltun and Lunskoye platforms. Goal is to protect entire structure above concrete gravity base.

Harold O. Sprague, Jr.
Black & Veatch Special Projects Corp.
August 2005

Andrew Whittaker and Michael Constantinou
Department of Civil, Structural and Environmental Engineering
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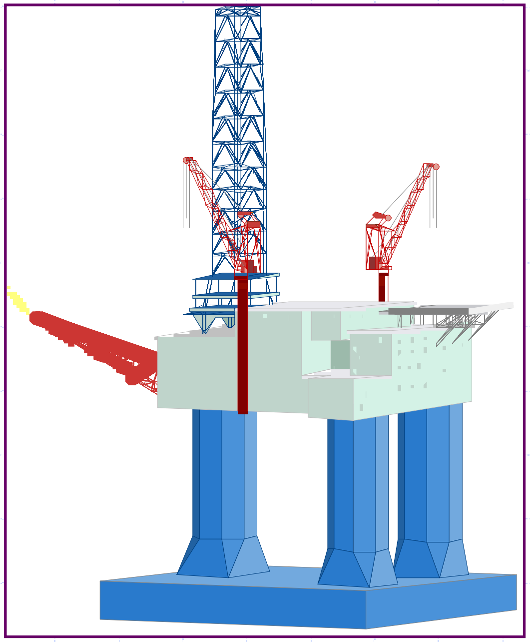
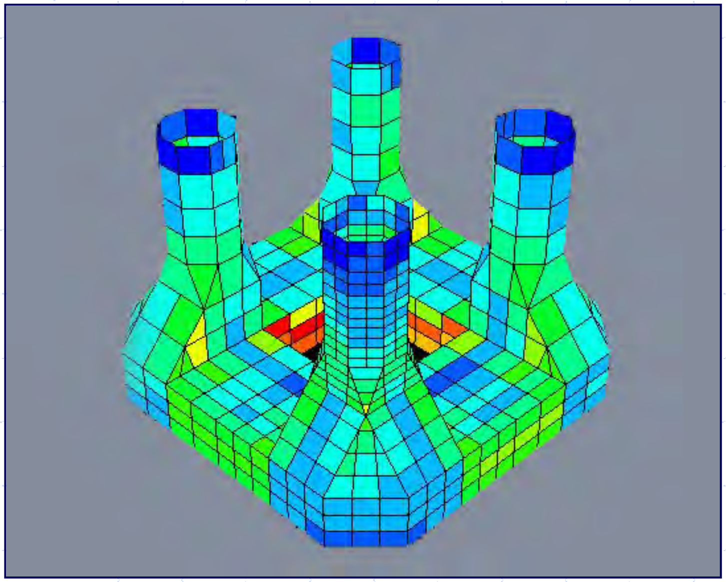
Sakhalin II gas platforms



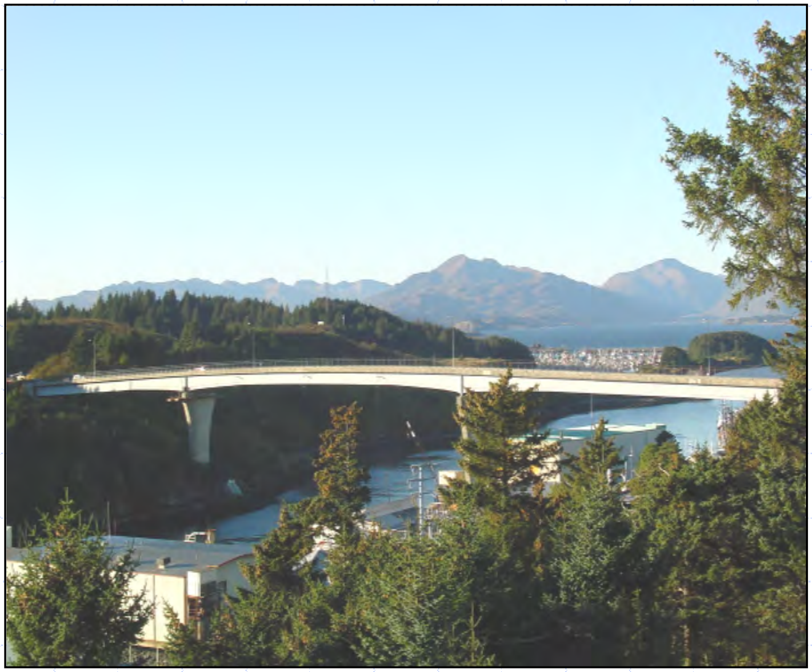


SAKHALIN II GAS PLATFORMS, RUSSIA
FP BEARINGS

Infrastructure applications

BENICIA-MARTINEZ BRIDGE
SAN FRANCISCO BAY AREA
FP BEARINGS

Infrastructure applications



KODIAK, ALASKA
FP BEARINGS

Infrastructure applications

BOLU VIADUCT, TURKEY
FLAT SLIDERS with YIELDING STEEL DAMPERS

Harold O. Sprague, Jr.
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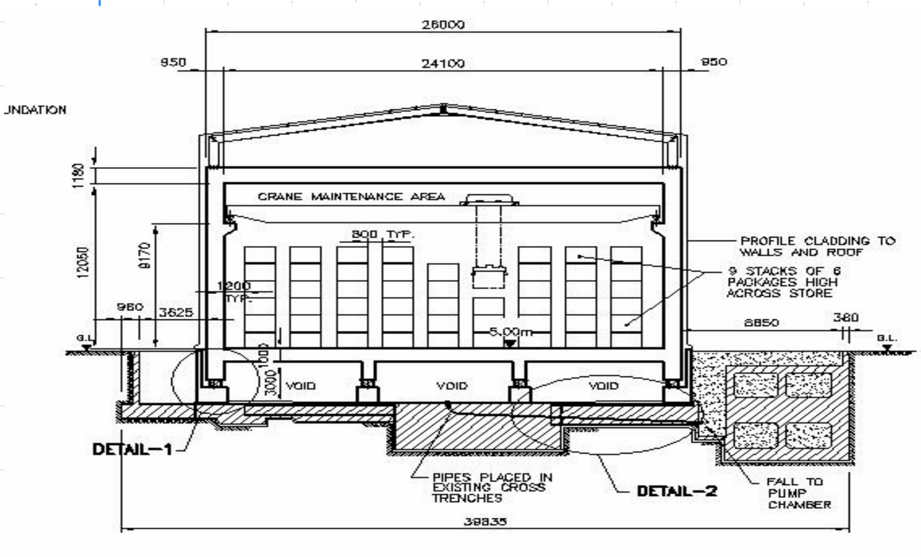
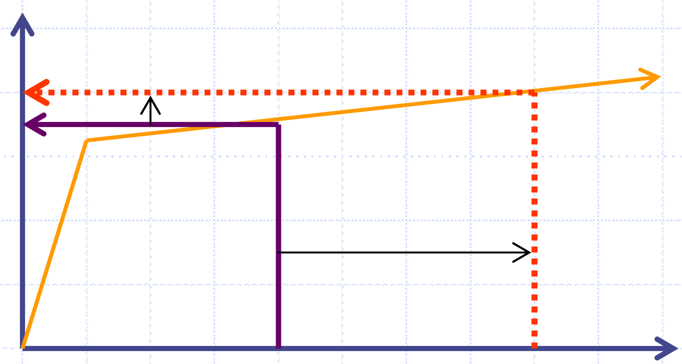
Building applications

Beyond-design-basis demands



- Conventional
  - Margin required?
  - Additional strength and stiffness
  - Ductile detailing
- Isolation



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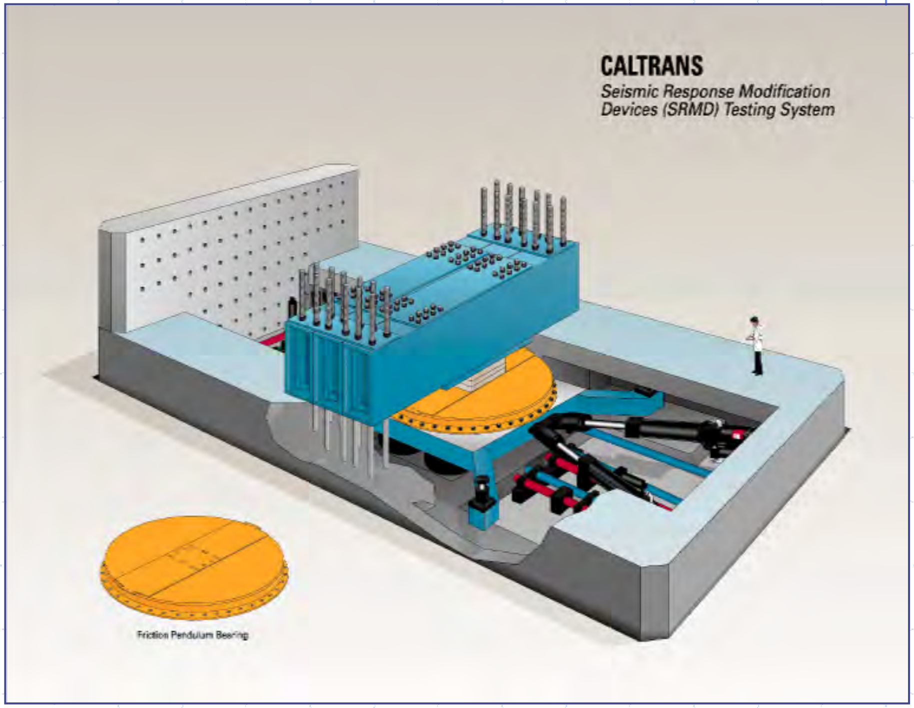
University at Buffalo

Testing of seismic isolators

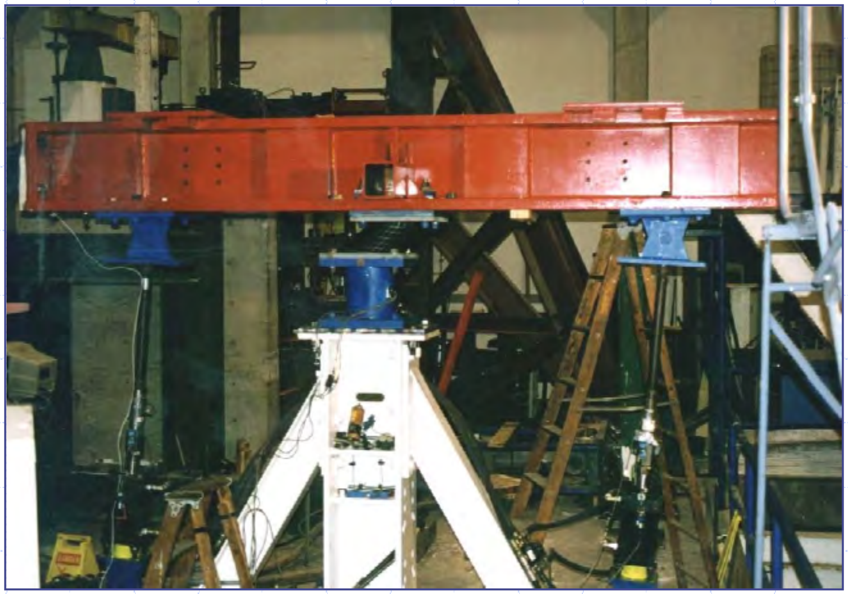
- Mandatory for
  - Buildings (NEHRP)
  - Bridges (AASHTO)
  - Nuclear (ASCE-4-98)
- Protocols
  - Prototype
  - Production
    - Quality control
- Velocity effects
  - Static testing
  - Dynamic testing



Full-scale dynamic testing

- Mission-critical hardware
  - Cyclic behavior
  - Degradation of response at high speeds
  - Construction quality
- SRMD Test Machine
  - Horizontal capacity
    - 4500 kN per actuator
    - 2500 mm stroke
    - 1.8 meters/sec
    - 19.3m^3/min servovalves
  - Vertical capacity
    - 72 MN

Small-scale dynamic testing



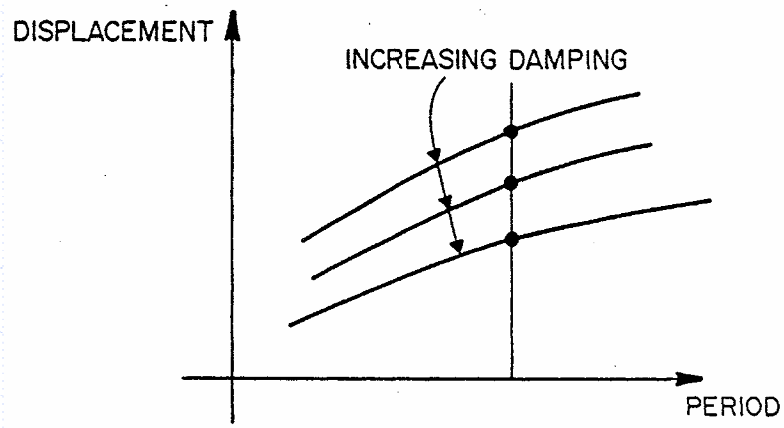
- Seismic protective systems
  - Seismic isolation
    - Hardware, applications, testing
  - Supplemental damping systems
    - Hardware, applications, testing

Principles of supplemental damping

- Reduce displacements
  - Eliminate nonlinear response in the gravity-load-resisting system
    - Possible?
    - Force inelastic action into specially designed and detailed, disposable components
- Reduce accelerations
  - Elastic systems?
  - Inelastic systems?

Effective Viscous Damping β (percentage of critical damping)[1]	B_S	B_1
≤ 2	0.8	0.8
5	1.0	1.0
10	1.3	1.2
20	1.8	1.5
30	2.3	1.7
40	2.7	1.9
≥ 50	3.0	2.0

1. Damping coefficients shall be based on linear interpolation for effective viscous damping values other than those given.



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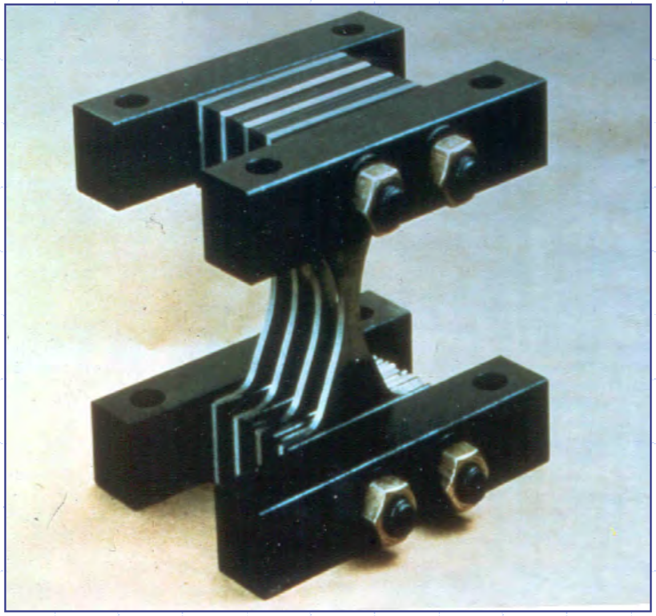
ADAS dampers

WELLS FARGO BANK, SAN FRANCISCO



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August 2005

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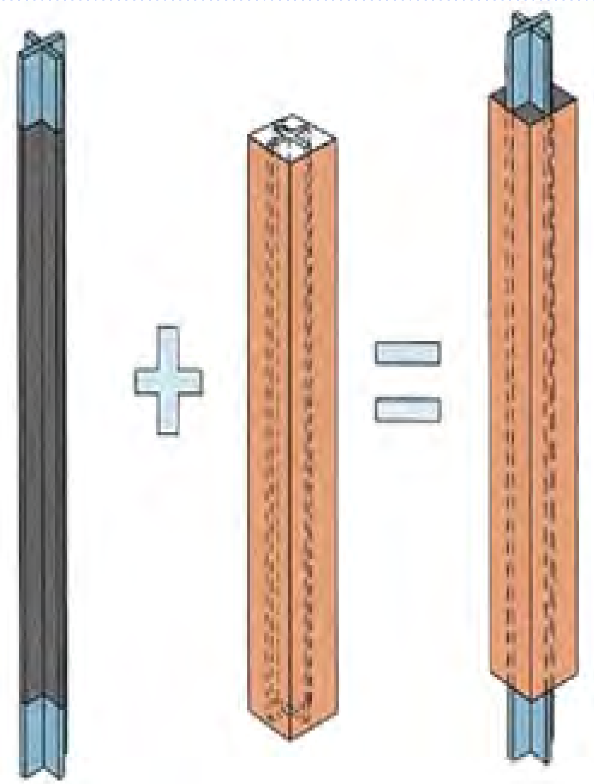
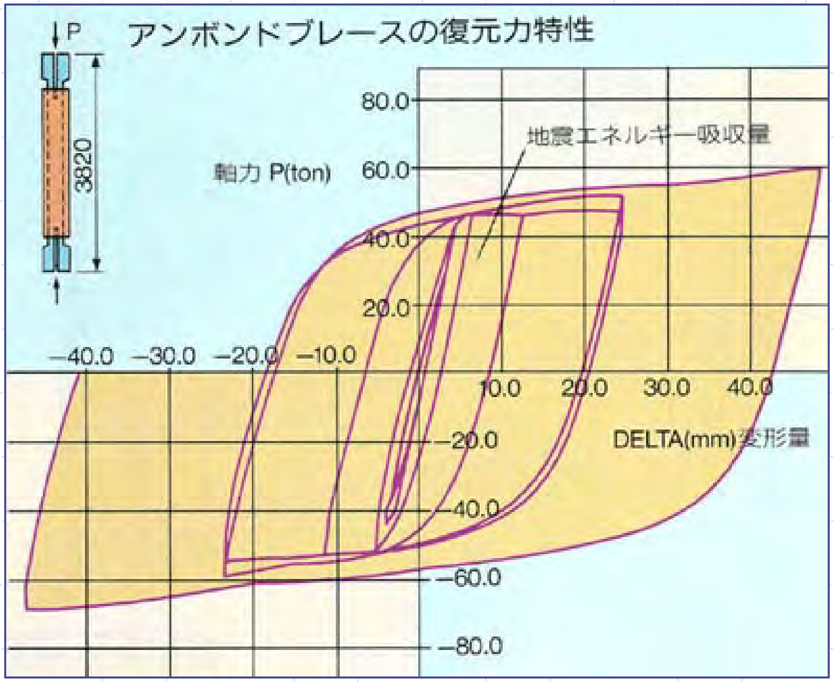
Unbonded braces





Harold O. Sprague, Jr.
Black & Veatch Special Projects Corp.
August 2005

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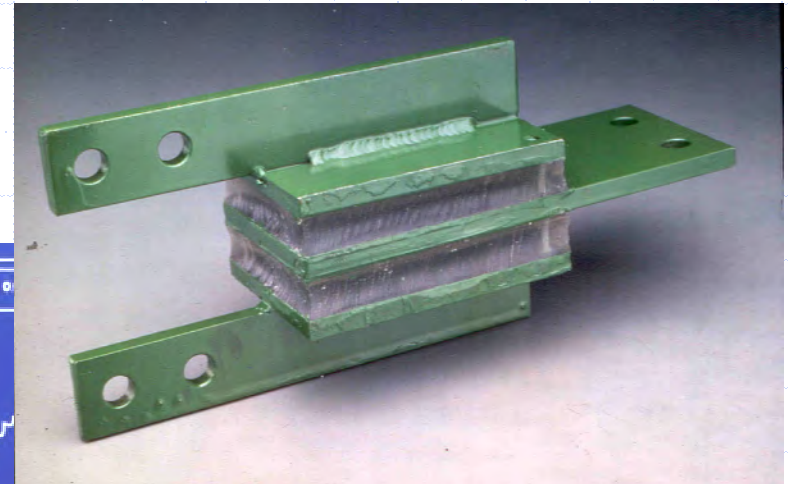
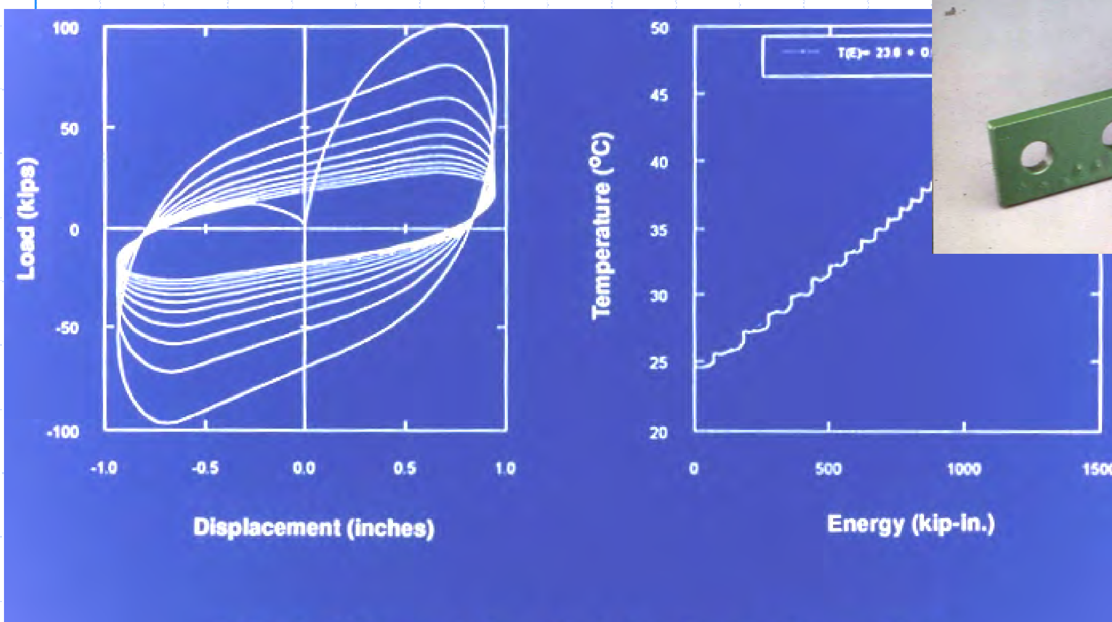
Unbonded braces

Solid VE dampers





10-Cycle 100 Percent Shear Strain Test Results, Damper No. 1

Harold O. Sprague, Jr.
Black & Veatch Special Projects Corp.
August 2005

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Department of Civil, Structural and Environmental Engineering
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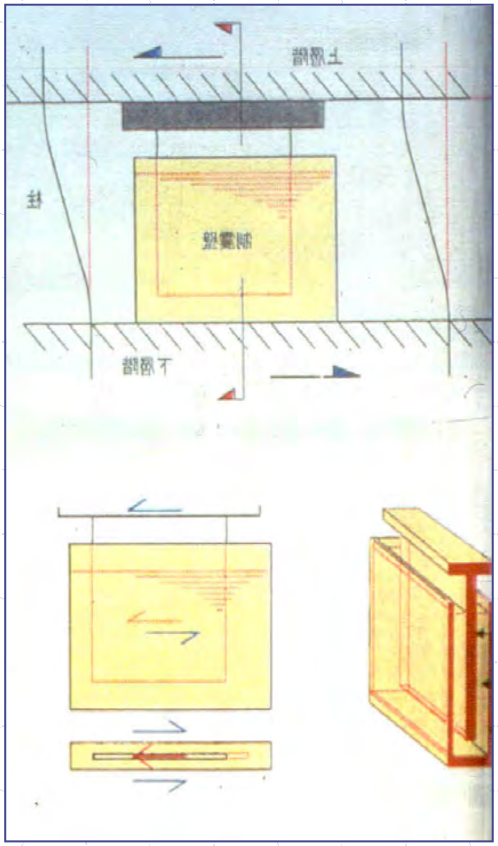
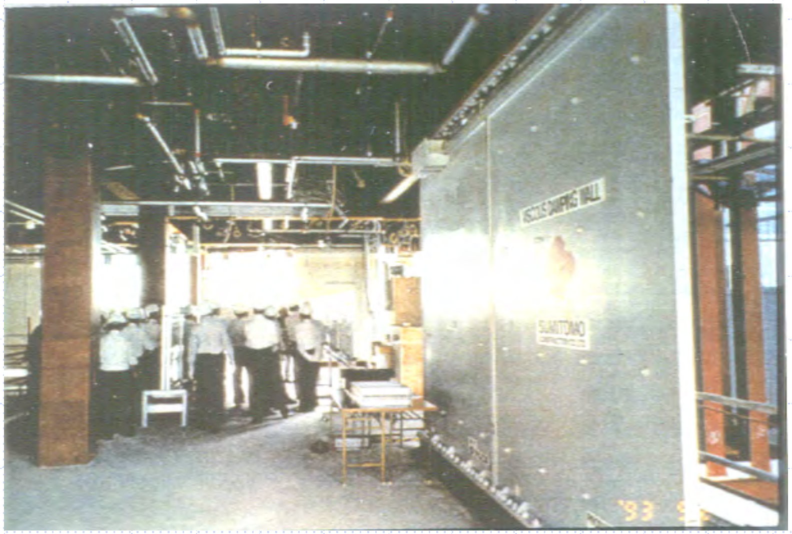
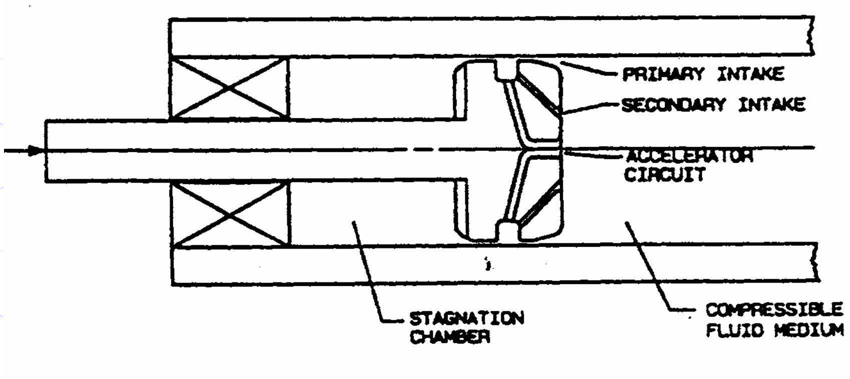
Fluid VE dampers

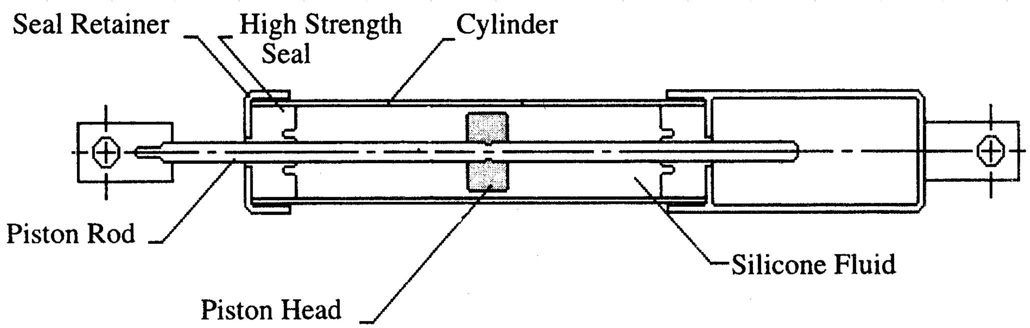




Fluid viscous dampers

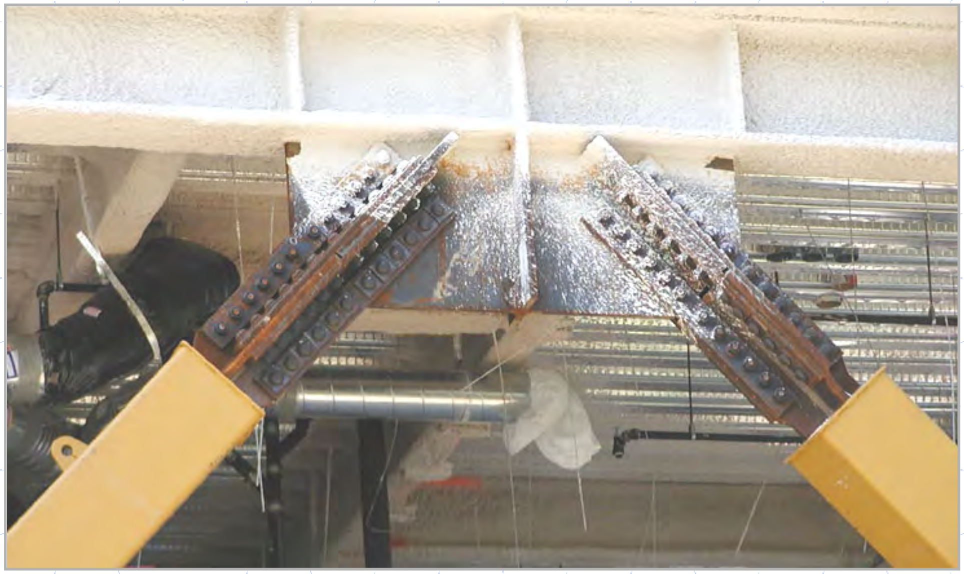


Fluidic Control Orifice



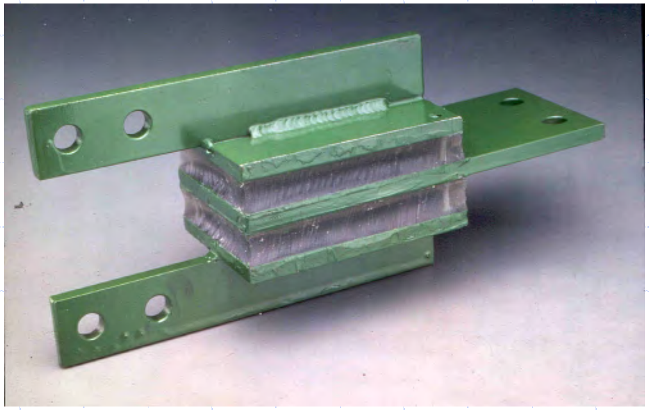
Building applications

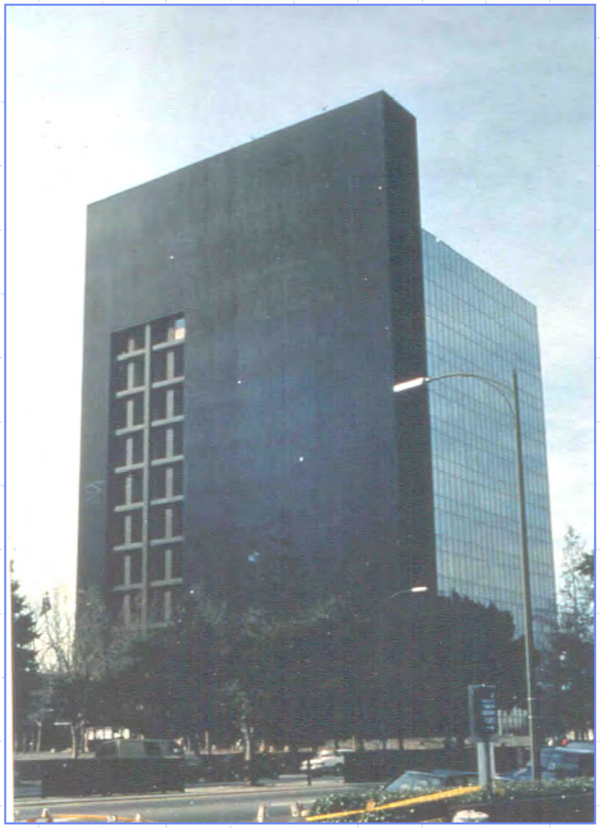
CENTRAL DINING FACILITY
UNIVERSITY OF CALIFORNIA, BERKELEY
UNBONDED BRACES



Building applications

SANTA CLARA COUNTY BUILDING,
SAN JOSE, CA,
SOLID VE DAMPER





Building applications

SAN FRANCISCO CIVIC CENTER
FLUID VISCOUS DAMPERS

Building applications

SAN FRANCISCO CIVIC CENTER
FLUID VISCOUS DAMPERS

Harold O. Sprague, Jr.
Black & Veatch Special Projects Corp.
August 2005

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University at Buffalo

Building applications (hybrid)

SAN BERNANDINO HOSPITAL, CA, ELASTOMERIC BEARINGS AND FLUID VISCOUS DAMPERS

Building applications (hybrid)

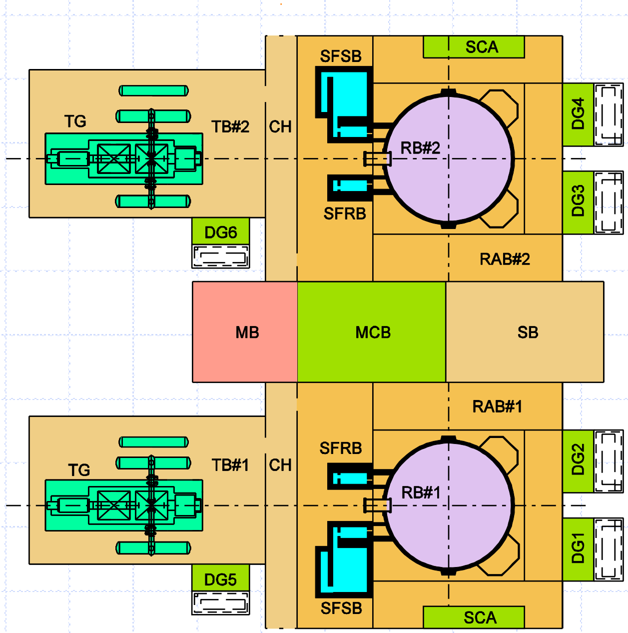
SAN BERNANDINO HOSPITAL, CA, ELASTOMERIC BEARINGS AND FLUID VISCOUS DAMPERS

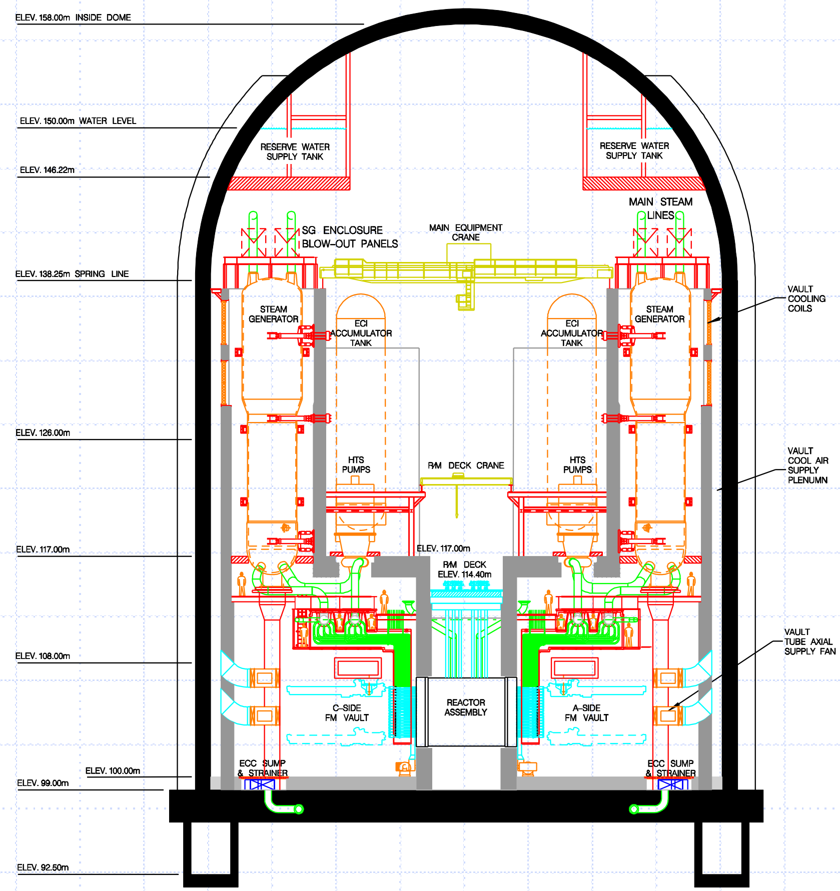
Testing of supplemental dampers

- Mandatory for
  - Buildings (NEHRP)
  - Bridges (AASHTO)
- Protocols
  - Prototype
  - Production
- Velocity effects
  - Static testing
  - Dynamic testing
    - Drop testing

Performance-based engineering

- Strategies for delivering performance
- Reliability
- Beyond-design-basis capability





ACR700

end

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Black & Veatch Special Projects Corp.
August 2005

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Consolidation of Structural Criteria for Military Construction

Environmental Quality and Installations

Mr. Steven Sweeney

Construction Engineering Research Laboratory

Engineer Research and Development Center

Champaign, IL

2005 Tri-Service Infrastructure Systems Conference
2 – 4 August 2005

Background

- Until recently:
  - Building Officials and Code Administrators International (BOCAI) published the National Building Code (NBC)
  - Southern Building Code Congress International (SBCCI) published the Standard Building Code (SBC)
  - International Council of Building Officials (IBCO) published the Uniform Building Code (UBC)
- These organizations now work through the International Code Council (ICC) to publish "The International Family of Codes" including the International Building Code (IBC)

Background

Environmental Quality and Installations

- National Fire Protection Association (NFPA) continues to publish the Life Safety Code (LSC) and the National Electric Code (NEC) and will soon publish NFPA 5000.
- Unfortunately, the joint venture known as the International Code Council and the NFPA have not succeeded in working together so the NFPA is developing a building code to compete with the IBC.

Background

- DoD needs consistent criteria for all construction
- Mission unique construction not covered in public codes
- Homeland security
- Rapid adoption of criteria for emerging technologies
- Problem solving

OMB Circular A-119

- Standards developed by voluntary consensus standards bodies are often appropriate for use in achieving federal policy objectives and in conducting federal activities, including procurement and regulation. The policies of OMB Circular A-119 are intended to:
  - Encourage federal agencies to benefit from the expertise of the private sector
  - Promote federal agency participation in such bodies to ensure creation of standards that are useable by federal agencies
  - Reduce reliance on government-unique standards where an existing voluntary standard would suffice.

Public Law 104-113, the ``National Technology Transfer and Advancement Act of 1995,''

- In February 1996, Section 12(d) of the Act was passed by the Congress in order to establish the policies of the existing OMB Circular A-119 in law. The purpose of Section 12(d) of the Act is to direct ``federal agencies to focus upon increasing their use of [voluntary consensus] standards whenever possible,'' thus, reducing federal procurement and operating costs

DoD Solution

- The International Building Code (IBC) has been adopted as the building code for DOD facilities. The IBC is a comprehensive commercial model building code that addresses all aspects of the design of facilities. The General Structural Criteria UFC is intended to:
  - not repeat the information in the IBC, but supplement it with DOD unique requirements (criteria) and best practices (commentary)
  - utilize the same organization and structure as the IBC with guidance referenced to the specific corresponding paragraphs within the IBC, and
  - include references to other structural guidance providing additional detailed topical criteria.

Overall Goal

- Develop a UFC; *Design: General Structural Criteria* that:
  - will provide a consolidated DoD design / construction document for facility designers / contractors.
  - Is Coordinated with the facility design and construction agencies for the Army, Navy, Air Force, and the Marine Corps
  - will be applicable for use by all DoD components and may also include and identify specific information and guidance applicable to individual DoD components where appropriate.

UFC Series	UFC Number	Preparing Activity	Title	Date(s) Pub	Existing Number
3-300	00		STRUCTURAL AND SEISMIC DESIGN		
3-300	10N	NAVFAC	General Structural Requirements	Aug-04	
3-301	00		GENERAL		
3-310	00		STRUCTURAL DESIGN CRITERIA		
3-310	01	USACE	Design: Load Assumptions for Buildings	30-Jun-00 03-Aug-98	TI 809-01
3-310	02	USACE	Structural Design Criteria for Buildings	1-Sep-99	TI 809-02
3-310	04	USACE	Seismic Design for Buildings	31-Dec-98	TI 809-04
3-310	05	USACE	Seismic Evaluation and Rehabilitation for Buildings	Oct-99	TI 809-05
3-310	07	USACE	Design of Cold-Formed Load Bearing Steel Systems and Masonry Veneer/Steel Stud Walls	30-Nov-98	TI 809-07
3-310	08	USACE	Masonry Structural Design for Buildings	Oct-92	TI-809-03

UFC		Preparing Activity	Title	Date(s)	Existing
Series	Number			Pub	Number
3-320	00		STRUCTURAL DESIGN GUIDANCE		
3-320	01	USACE	Welding - Design Procedures and Inspections	1-Mar-00	TI 809-26
3-320	03	USACE	Design and Construction of Conventionally Reinforced Ribbed Mat Slabs (RRMS)	15-Sep-99	TI 809-28
3-320	04	USACE	Structural Considerations for Metal Roofing	30-Aug-98	TI 809-29
3-320	05	USACE	Metal Building Systems	1-Aug-98	TI 809-30
3-320	06	NAVFAC	Weight Handling Equipment	Mass	1038
3-320	06	USACE	Structural Design Criteria for Structures Other Than Buildings	Dec-91	TM 5-809-6
3-320	07	USACE	Concrete Floor Slabs on Grade Subjected to Heavy Loads	25-Aug-87	TM 5-809-12

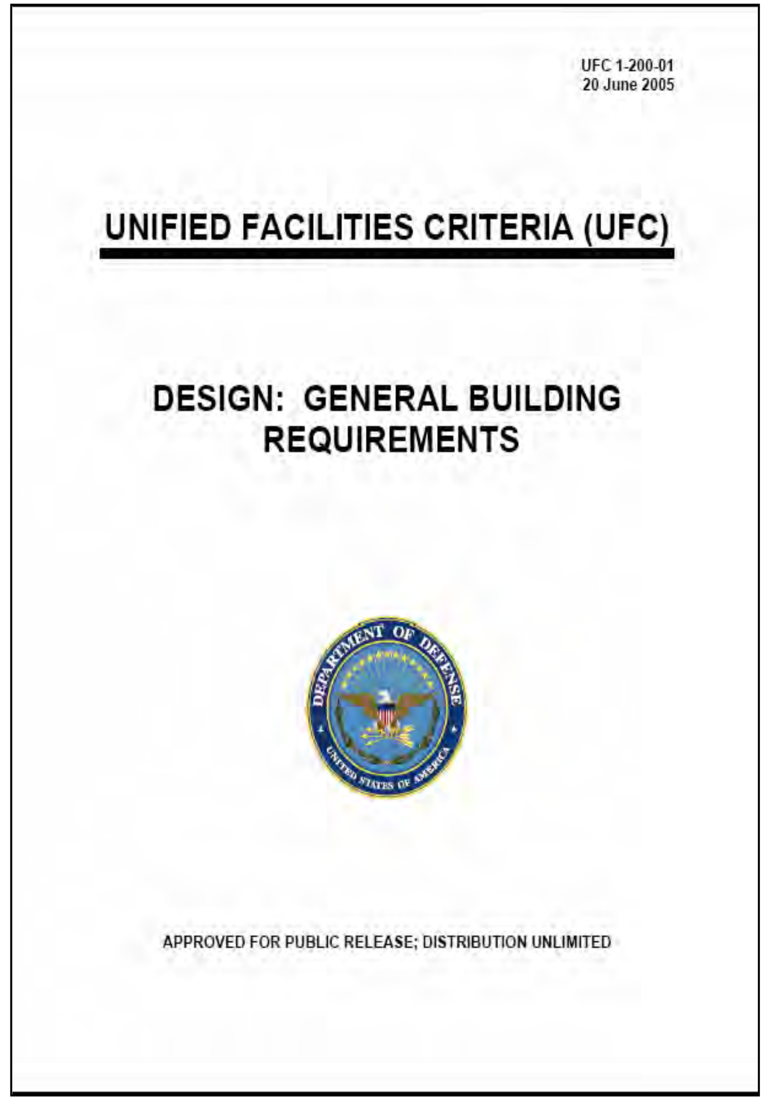
UFC Series	UFC Number	Preparing Activity	Title	Date(s) Pub	Existing Number
3-330	00		Structural Commentary		
3-330	01	USACE	Commentary on Snow Loads	XXX	TI 809-52
3-330	02	USACE	Commentary on Roofing Systems	1-May-99	TI 809-53
3-330	03	USACE	Seismic Review Procedures for Existing Military Buildings	30-Sep-99	TI 809-51

Problems with Existing Criteria

- Adoption of IBC has created guidance that is overlapping conflicting with many of the existing legacy documents
- Not up to date
- Dead references
- Expensive to maintain

UFC 1-200-01

- The starting point for merging all code modifications to the IBC contained in the DOD structural design documents.
- Is intended to be a very small code adoption document that refers to other discipline specific UFCs for more detailed guidance.
- If any conflict exists between this UFC and additional service specific guidance, the service specific guidance shall take precedence.


UFC 1-200-01
20 June 2005

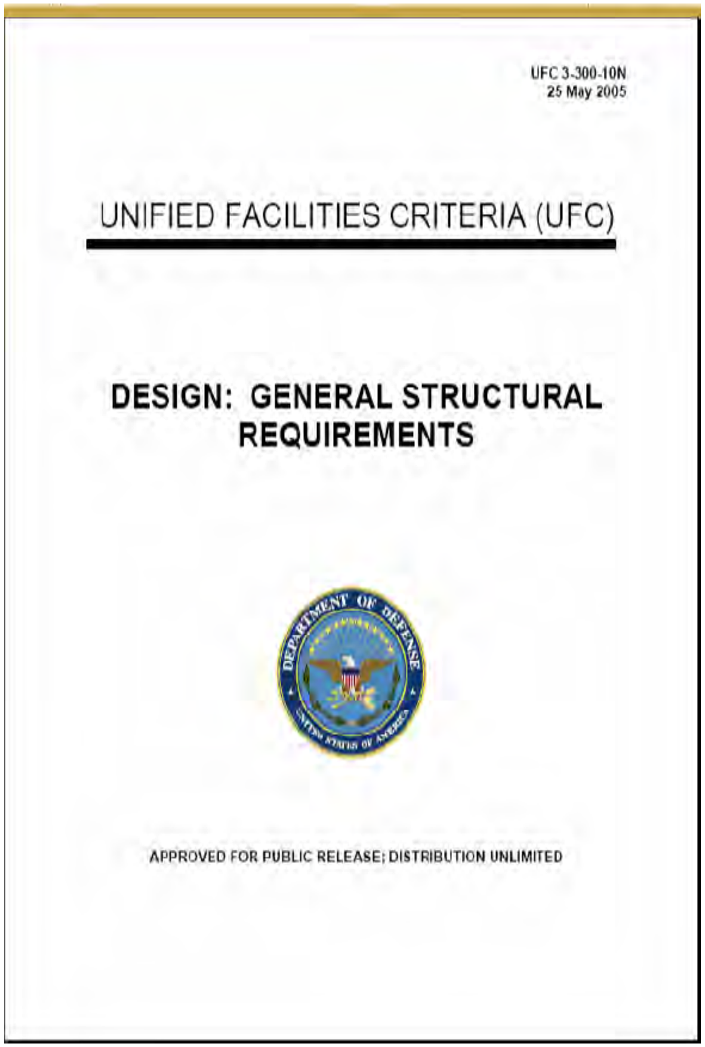
UNIFIED FACILITIES CRITERIA (UFC)

DESIGN: GENERAL BUILDING REQUIREMENTS

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

UFC 3-300-10N

- Navy document.
- Updated to eliminate redundancies and refer to the new UFC for progressive collapse prevention for guidance.


UFC 3-300-10N
25 May 2005

UNIFIED FACILITIES CRITERIA (UFC)

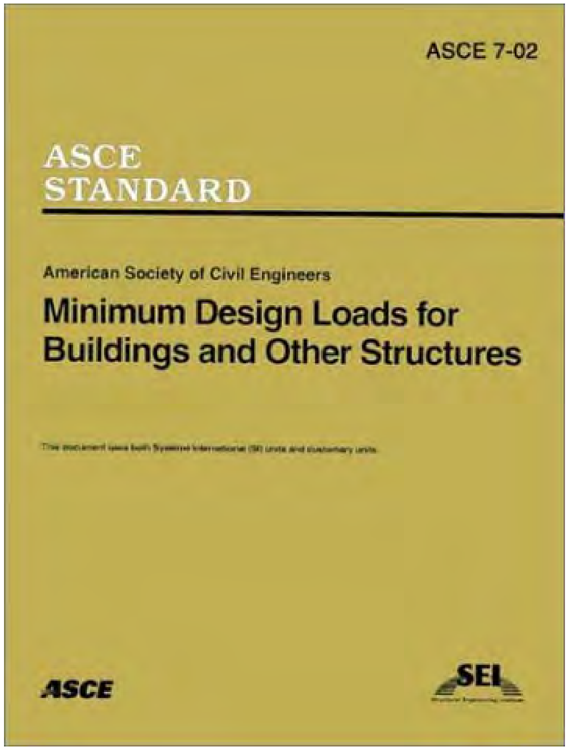
DESIGN: GENERAL STRUCTURAL REQUIREMENTS

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

UFC 3-310-01

Environmental Quality and Installations

- ASCE 7 with additions and exceptions
- Continue to publish as a stand alone document



ASCE 7-02

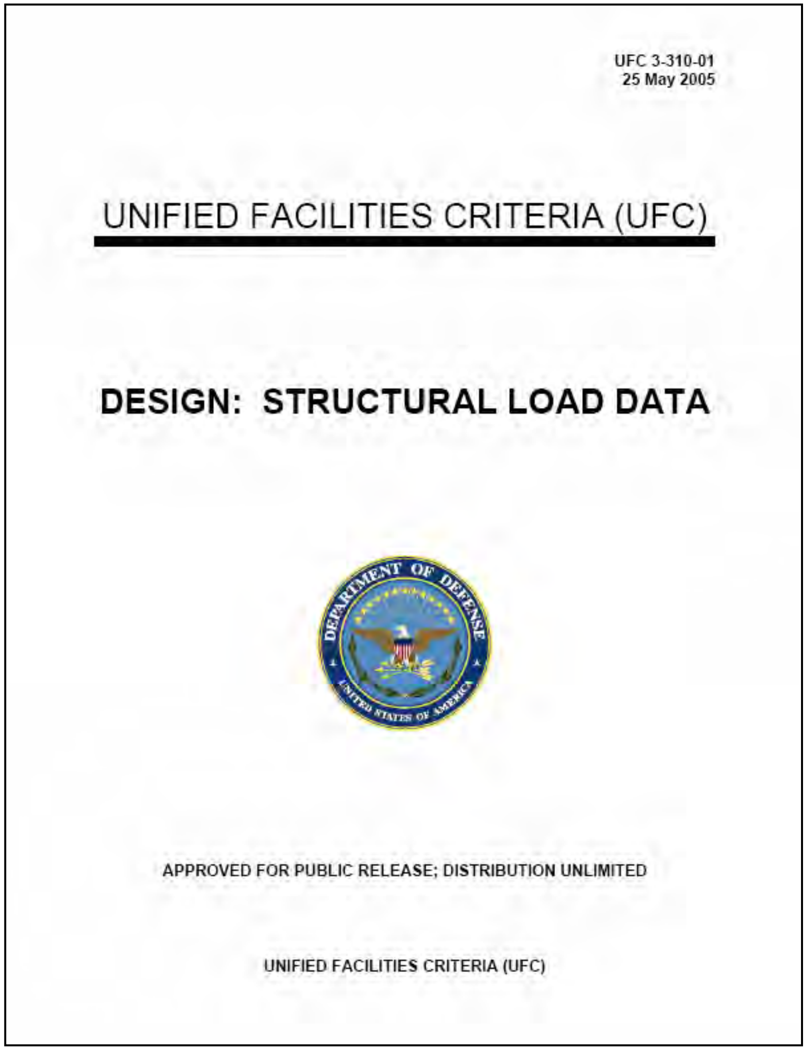
ASCE STANDARD

American Society of Civil Engineers

Minimum Design Loads for Buildings and Other Structures

ASCE

SEI



UFC 3-310-01
25 May 2005

UNIFIED FACILITIES CRITERIA (UFC)

DESIGN: STRUCTURAL LOAD DATA

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

UNIFIED FACILITIES CRITERIA (UFC)

UFC 3-310-02A (TI 809-2)

- Contains more structural design commentary than structural criteria.
- Code material in this document will form the basis of structural DOD-specific code modifications to the IBC.
- Commentary material could be combined into a general structural commentary document with any duplicated material removed.


UFC 3-310-02A
1 MARCH 2005

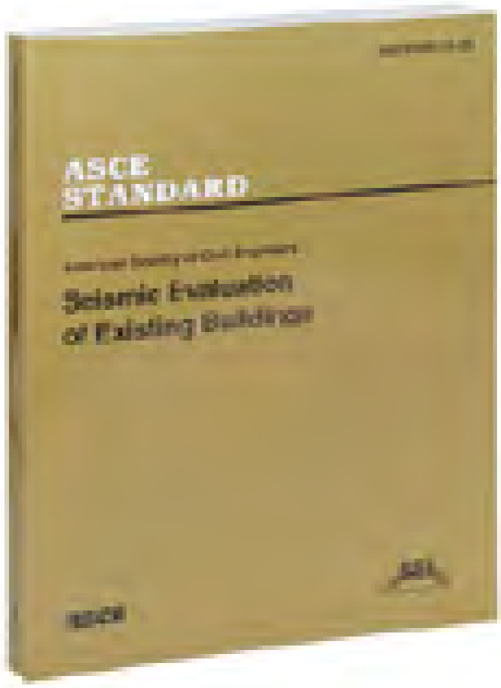
UNIFIED FACILITIES CRITERIA (UFC)

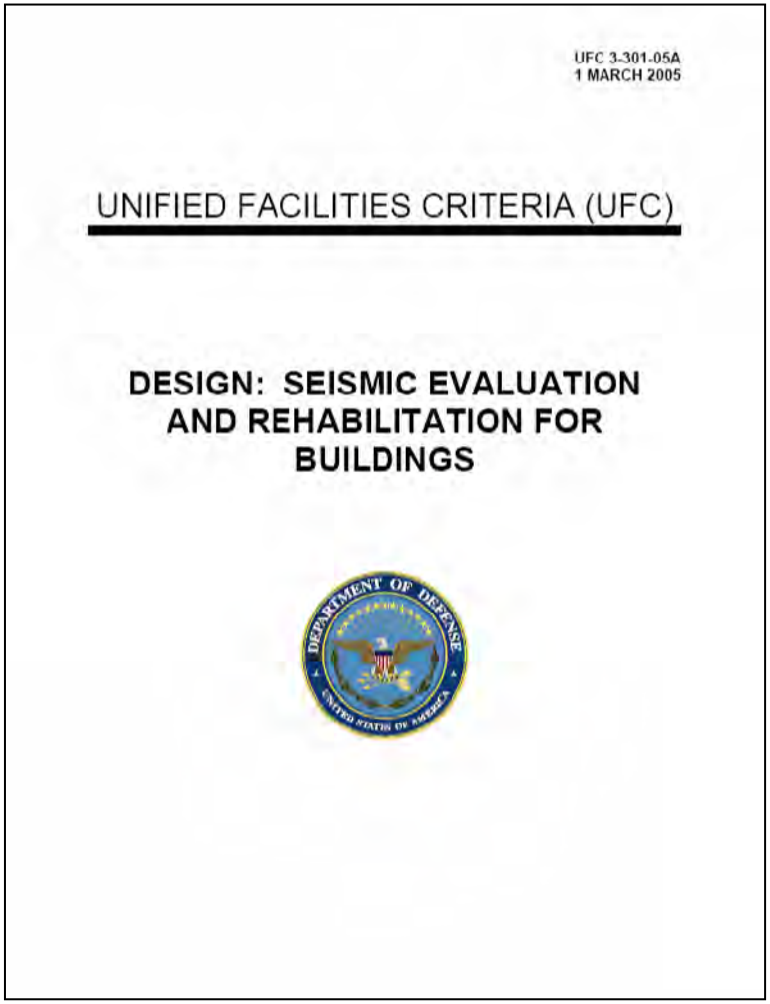
DESIGN: STRUCTURAL DESIGN CRITERIA FOR BUILDINGS

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

UFC 3-301-05A (TI 809-05)

- This document will be eliminated, use ASCE 31 for evaluation.



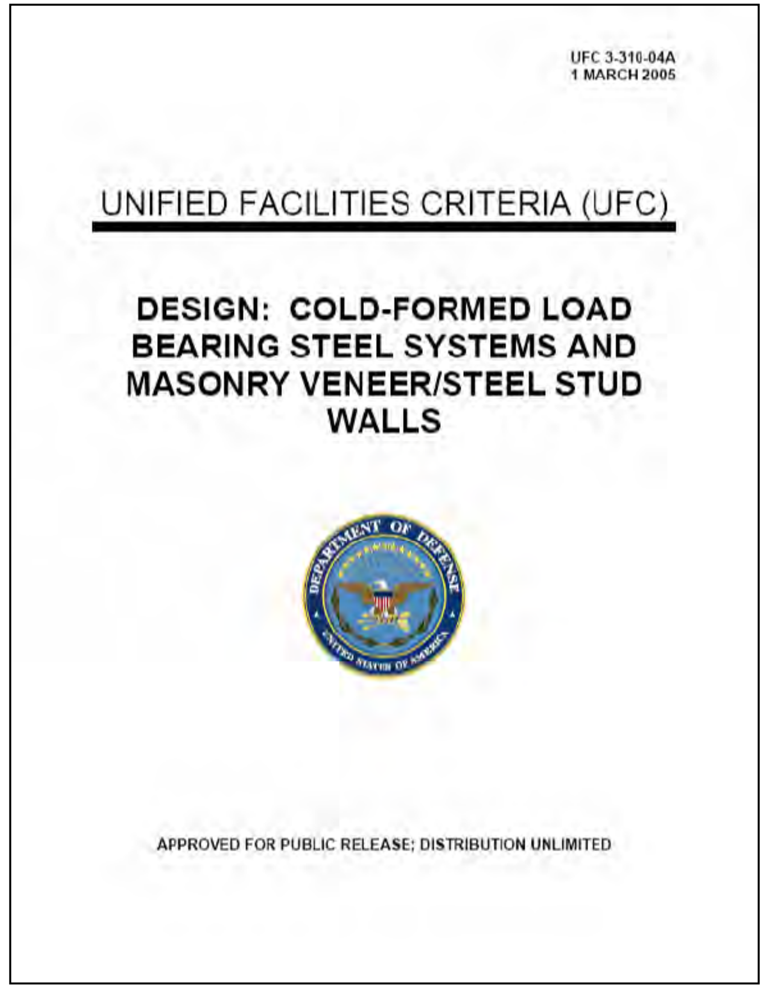

UFC 3-301-05A
1 MARCH 2005

UNIFIED FACILITIES CRITERIA (UFC)

DESIGN: SEISMIC EVALUATION AND REHABILITATION FOR BUILDINGS

UFC 3-301-04A
(TI 809-07)

- Relatively new criteria.
- No current acceptable industry standards
- Will be maintained as a separate document.


UFC 3-310-04A
1 MARCH 2005

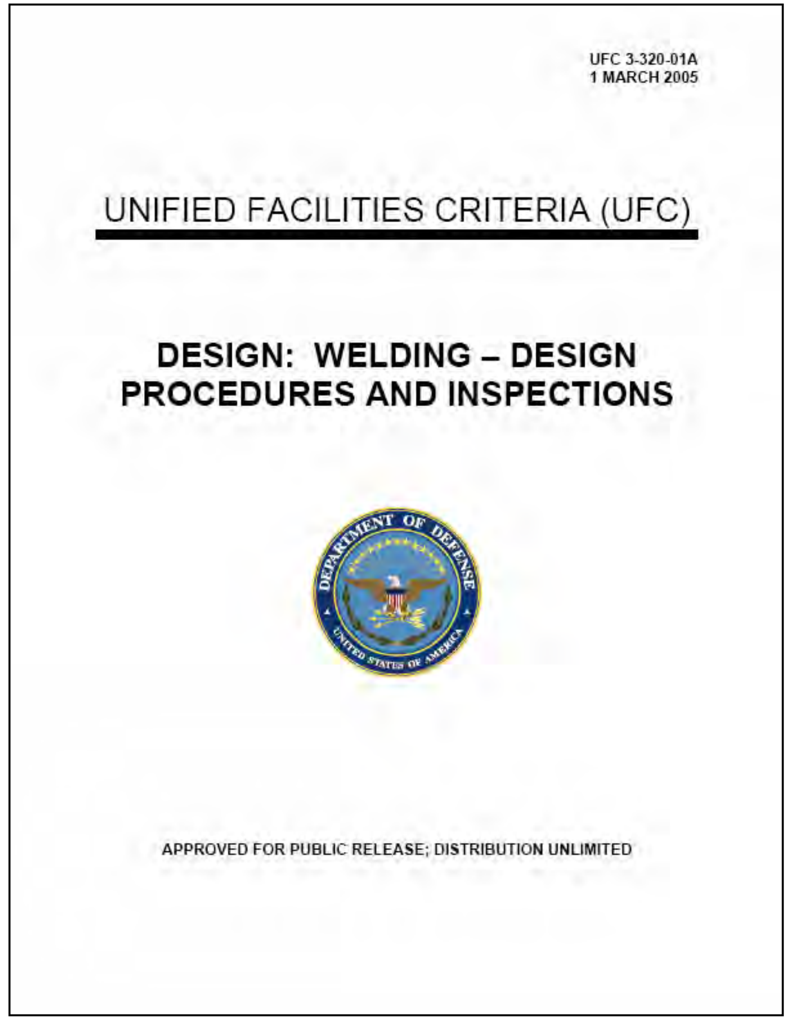
UNIFIED FACILITIES CRITERIA (UFC)

DESIGN: COLD-FORMED LOAD BEARING STEEL SYSTEMS AND MASONRY VENEER/STEEL STUD WALLS

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

UFC 3-320-01A (TI 809-26)

- Last Revised 1 March 2000.
- Very comprehensive, pulls information from several sources into one document
- Combines multiple criteria, including AWS, AISI, ASTM, AISC …
- No determination has been made regarding future disposition


UFC 3-320-01A
1 MARCH 2005

UNIFIED FACILITIES CRITERIA (UFC)

DESIGN: WELDING – DESIGN PROCEDURES AND INSPECTIONS

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

UFC 3-320-02A (TI 809-28)

- A guidance document, not criteria
- Should be incorporated into concrete section of UFC 3-310-02 or as an appendix


UFC 3-320-02A
1 MARCH 2005

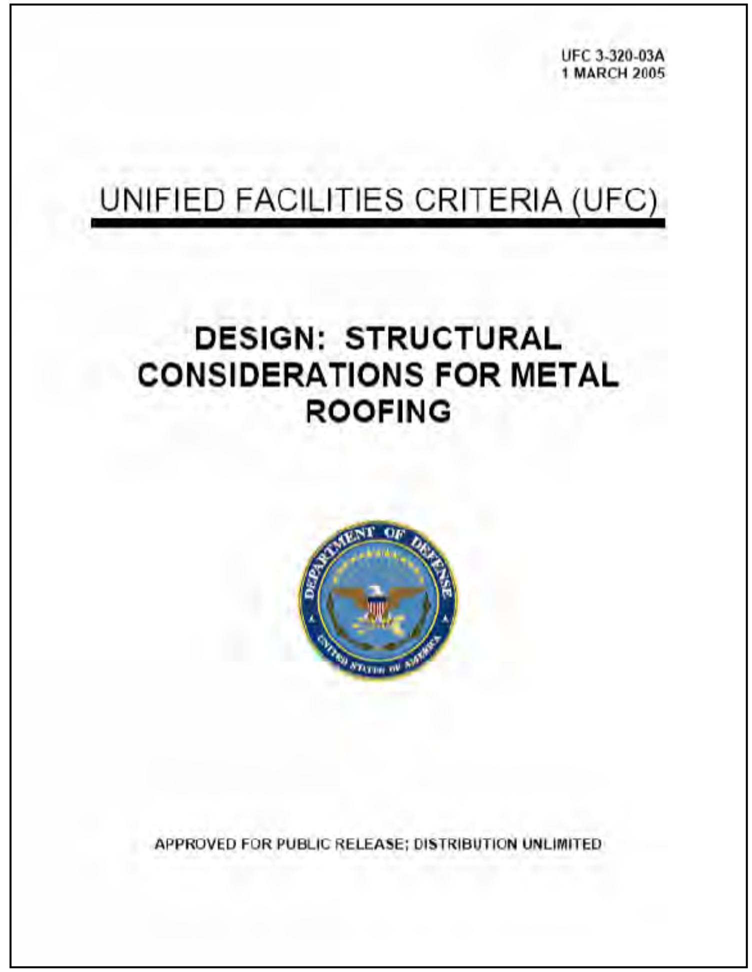
UNIFIED FACILITIES CRITERIA (UFC)

DESIGN: DESIGN AND CONSTRUCTION OF CONVENTIONALLY REINFORCED RIBBED MAT SLABS (RRMS)

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

UFC 3-320-03A (TI 809-29)

- Last updated in 1998
- Combination of criteria and commentary
- Can be incorporated into sections of UFC 3-310-02 and an appendix


UFC 3-320-03A
1 MARCH 2005

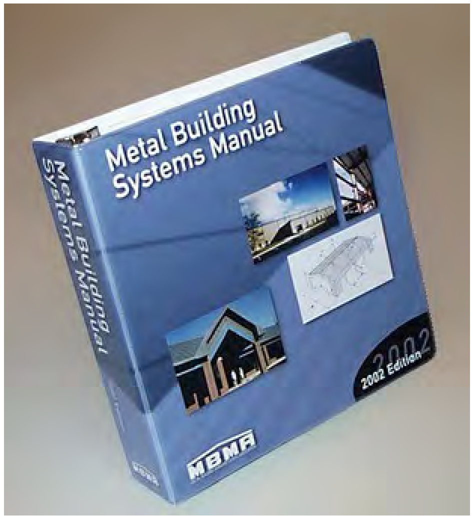
UNIFIED FACILITIES CRITERIA (UFC)

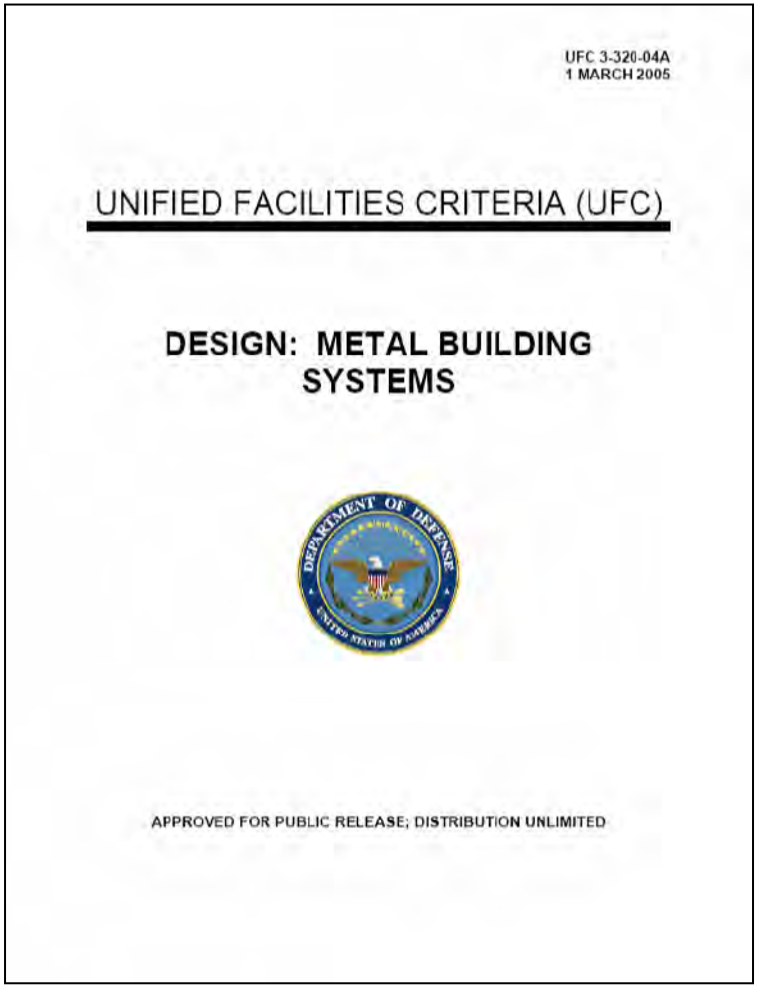
DESIGN: STRUCTURAL CONSIDERATIONS FOR METAL ROOFING

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

UFC 3-320-04A (TI 809-30)

- MBSM has become a national standard.
- Incorporate exceptions and commentary into sections of UFC 3-310-02





UFC 3-320-04A
1 MARCH 2005

UNIFIED FACILITIES CRITERIA (UFC)

DESIGN: METAL BUILDING SYSTEMS

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

UFC 3-320-06FA (TI 809-12)

Environmental Quality and Installations

- Last updated in 1987!
- Should be incorporated into concrete section of UFC 3-310-02 or an appendix.


UFC 3-320-06FA
1 MARCH 2005

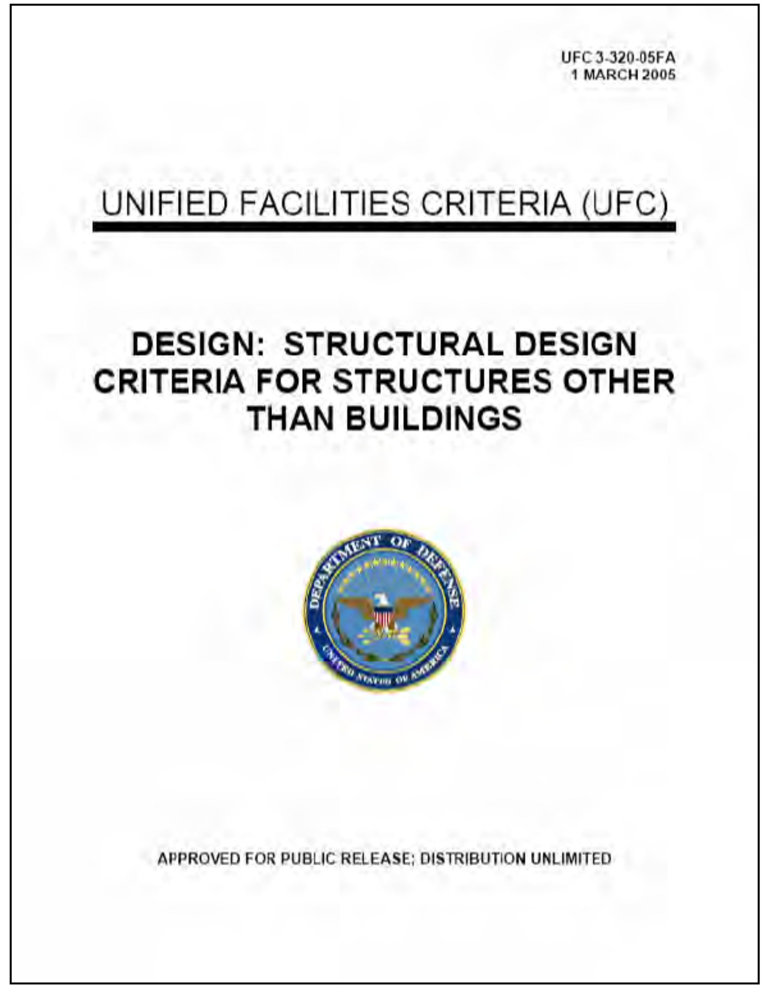
UNIFIED FACILITIES CRITERIA (UFC)

DESIGN: CONCRETE FLOOR SLABS ON GRADE SUBJECTED TO HEAVY LOADS

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

UFC 3-320-05FA (TI 809-06)

- Last updated in 1991.
- Primarily references criteria to be used for each type of non-building structure, which are now out of date
- IBC covers non-building structures
- Needs to be updated or eliminated


UFC 3-320-05FA
1 MARCH 2005

UNIFIED FACILITIES CRITERIA (UFC)

DESIGN: STRUCTURAL DESIGN CRITERIA FOR STRUCTURES OTHER THAN BUILDINGS

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

Structural Commentary

UFC		Preparing Activity	Title	Date(s)	Existing
Series	Number			Pub	Number
3-330	00		Structural Commentary		
3-330	01	USACE	Commentary on Snow Loads	XXX	TI 809-52
3-330	02	USACE	Commentary on Roofing Systems	1-May-99	TI 809-53
3-330	03	USACE	Seismic Review Procedures for Existing Military Buildings	30-Sep-99	TI 809-51

- These documents are not criteria. The information should be included as an appendix to UFC 3-310-02 as needed and eliminated

UFC 3-310-03A (TI 809-04)

- This document is currently being updated. Anticipated that new document will be published this CY
- Significant exceptions to IBC
- Lots of commentary


UFC 3-310-03A
1 MARCH 2005

UNIFIED FACILITIES CRITERIA (UFC)

DESIGN: SEISMIC DESIGN FOR BUILDINGS

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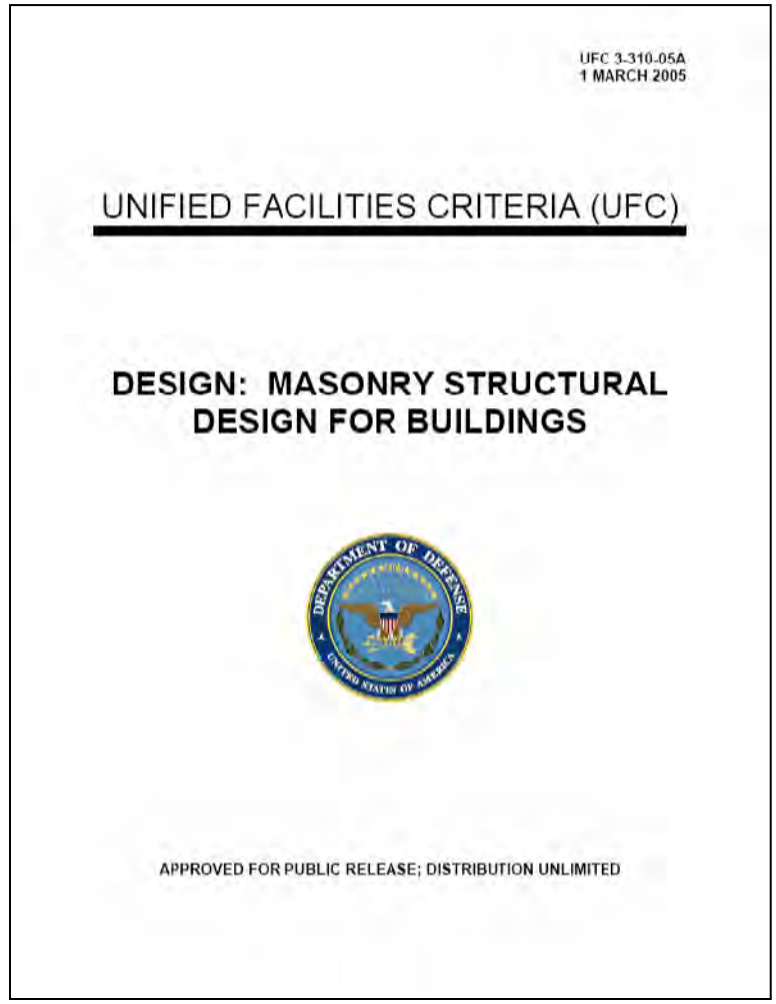
UFC 3-310-05A
(TI 5-809-03

- Currently being updated (publish this CY)
- Major reduction in content
- Exceptions to IBC
- Extensive commentary
- Eventually will be combined with general structural UFC


UFC 3-310-05A
1 MARCH 2005

UNIFIED FACILITIES CRITERIA (UFC)

DESIGN: MASONRY STRUCTURAL
DESIGN FOR BUILDINGS

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

Current Effort

- Development of UFC 3-310-02 to update TI 5 809-02 and eliminate of TI 5-809-51, TI 5-809-05, TI 5-809-30, with appropriate references and exceptions identified within the document.

Project Schedule

• Preliminary Draft General Structural UFC	**30 Sep 2005**
• Pre-final Draft General Structural UFC	**1 Jan 2006**
• Tri-service review Meeting	**1 Feb 2006**
• Final General Structural UFC	**1 Mar 2006**

Summary

- The UFC 1-200-01 establishes the IBC as the DoD design standard as modified by our criteria.
- There are several structural design UFCs which can be reduced/consolidate with UFC 3-310-02
  - Many of the past concerns addressed by DoD in these documents have been addressed in current codes.
- Other criteria considered unique
  - These areas are not appropriately addresses in current codes, therefore these documents should remain stand alone criteria.